ROADS And STREETS

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The Batching Arrangement

OREGON BUILDS CEMENT BOUND MACADAM TEST ROAD

A TEST section of cement bound macadam built by the Oregon State Highway Department during 1934, brought out the interesting result that, even with inexperienced workers, a satisfactory riding surface could be produced without the use of a smoothing course. Elimination of such a course increased the rate of production and lowered the cost appreciably.

The project consists of 2,651 ft. of 20-ft., 6 in. cement bound macadam slab. It was built on the Dixie-Lime section of the Old Oregon Trail.

The heavy equipment used consisted of a motor grader with scarifier attachment, a 10-ton roller, two transit mixers, a job made hand screed, and trucks for hauling the coarse aggregates. Had a 5-ton roller been available, it would have been preferable.

Preliminary Work.—In general, standard practices were followed. The grader, equipped with scarifiers, was used to smooth and grade the entire roadbed section between stations. Both full and half width construction was tried. The half width construction was superior. For side forms, 3 x 6's, 16 ft. long were used, held in position by 3 x 3 x 20-in. stakes driven on alternate sides of the form at 5½ ft. intervals, four stakes to each section.

Expansion joints were of 1 x 6's, 20 ft. long. These were placed by hand after preliminary rolling, a trench being shoveled out, the joints set, and the trench backfilled and tamped solid with a pavement tamper.

On the full-width roadway, longitudinal joints were held in place with pavement pins, which were removed after rolling prior to grouting. On the half-width construction one edge of the finished section was used as a form. Otherwise the procedure was the same.

Coarse aggregate consisted of a 1¼ in. x 2¼ in. crushed rock. This was trucked approximately 8 miles in 4 cu. yd. trucks. It was spread with the motor grader and rolled. Low spots were filled in with shovels and rolled again. The surface was then spotted a final time filling all low spots, and tamped by hand. A 6 in. compacted depth of the ungrouted stone was thus obtained.

Preparation of Grout.—Batching for the grout was done near the work, where a platform was equipped with a scale for weighing sand. Proportions used for most of the grout were one part cement and two parts sand, with enough water added to give a satisfactory grout flow. The water tank was high enough above the mixer to utilize gravity flow. This grout was charged in two transit mixers, which were unable to set a hard

Test Road on the Old Oregon Trail

pace for the work. It is believed three mixers would have developed the greatest production on this job.

Mixers were charged dry, with the mixers operating while being charged. A well-mixed grout was obtained with this procedure.

Application of Grout.—Compacted aggregate was sprinkled immediately before the grout was spread. This made a marked improvement in grout penetration and when grout of the proper fluidity was used on freshly sprinkled aggregate, no difficulty was experienced in obtaining complete penetration.

To prevent displacement of aggregate, grout was dis-

Full Width Construction. With Forms in Place the Blade Spreads the Stone

charged from the Transit mixer through a spout to a distributor box. This box was about 6 in. deep, 1 ft. wide and 2½ ft. long. One inch holes were spaced 3 in. from center to center over the entire bottom of the box. This provided a uniform flow of the grout. Excess grout was broomed ahead by laborers.

It was found that the 10-ton roller was too heavy to use on the grouted stone. It displaced the stone so much that a satisfactory riding surface could not be obtained. A 12 ft. hand tamp was made of an I-beam, equipped with plow handles at each end, and weighing 12 lb. per lineal foot. This was operated by two men and gave excellent results.

The Finish Cost.—Lack of experience in finishing cement bound macadam caused the engineers to anticipate some trouble in obtaining satisfactory surface texture and riding properties. Two schemes were proposed: one, to finish with a ½ in. layer of mixed concrete; the other, to finish with a thin course of sheet asphalt.

The first scheme resembles closely the Australia standard practice in finishing cement bound macadam. A mix of 1 part cement, 2 parts sand and 2 parts ¼ in. to ½ in. coarse aggregate was used. As soon as the rough finish had been given the base, the finish coat was added, being dumped direct from truck to pavement without spout or distributing box. After the mortar was spread over the surface, a screed was used to shape the surface. The surface was then floated with long handled floats, checked with a 10-ft. straight edge, high spots were removed with a bull float and burlap was dragged over the surface to remove excess water and prepare it for brooming.

Following the burlap drag, two men leveled joints, trued edges and patched any small places that needed such attention. These men also gave the final brooming. With this method of finishing a riding surface comparable to mixed concrete was obtained.

The second method of finishing was to be a sheet asphalt surface over the rough finished concrete. Later it was decided to substitute an oil mat surface for the sheet asphalt, because of lower cost. It was believed that less care need be used in bringing the surface of the concrete to a smooth finish and that the oil mat could be applied more economically than the special mixed concrete to take out the expected surface irregularities. Before the oil mat was applied, riding properties of the cement bound macadam base were tested and found so satisfactory that the concrete, asphalt, or oil mat course was not necessary. The roughness of this section of surface produced by an inexperienced crew is estimated at not to exceed 75 vertical inches per mile. With ex-

Initial Compaction with a 10-Ton Roller

perience gained here, better results could be had on future work.

Costs.—Complete cost records were kept throughout the study. The cost of the 5½ in. uniform thick, rough-finished pavement (final thickness after last compaction) was $.94 per square yard, or the equivalent of $9,930 per mile for an 18-ft. pavement. The addition

Checking the Stone Surface with a Template Before Grouting

Grout Was Discharged Through a Spout to the Distributor Box

of ½ in. of mortar, finished, raised this cost to $12,500. With the mortar finish, a surface comparable with the best obtained on any concrete pavement was had.

Curing was maintained for approximately ten days. Wet burlap was kept in place for a minimum of 48 hours. On some of the work the burlap was kept wet throughout the curing period. On other parts the ponding method was used for curing and on still others the surface was kept wet by watering it with a hose.

Joints.—Transverse joints were spaced at 60, 90 and 120 ft. intervals. Inspection after completion showed that few cracks had developed with the 60 ft. spacing. Enough cracking had developed in the other sections to indicate that joint spacing should not exceed 60 ft.

Several methods were used in placing longitudinal joints. The most satisfactory was to place the 1 x 4, used for the dummy joint, directly on the subgrade. This provided a 2 in. cover, which produces only a hair crack that follows the joint.

While it is recognized that cost figures from a small job of this character do not furnish a satisfactory basis for computing costs on all jobs it is believed that, on a normal construction job, the cost would tend to be lower rather than higher.

Considerable savings may be realized where coarse aggregate is obtained near the job. On a test road, where methods are being changed frequently, efficient organization is difficult to obtain. Likewise, it takes some experience before the crew becomes efficient with a new process and the entire organization on this work was "starting from scratch" with cement bound macadam.

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Name Wanted

Just because "diversion" suggests everything between a game of parchesi and gay night life, motor vehicle owners and their organizations are looking for a word that means something else.

For a long while, these folks have been vexed by the shifting of money raised by gasoline taxes to state funds having no connection with highway building. They have been referring to this practice as diversion. Now they find lots of people think they have been talking about "a good time."

Some word-coiners have suggested "tax-jacking," "taxateering" and similar combinations. But, to date, none of these has found its way into the working vocabulary used by motorists.

Perhaps somebody will put an end to the whole affair by writing to Athens to see if the Greeks really do "have a word for it."

One-sixth of Jobs Depend Upon Purchases by Motorists

Work and wages for one out of every six persons in the nation's wholesale, retail and service trades are provided by firms wholly dependent upon automotive, petroleum, tire and other sales connected with highway use.

This was revealed in a statement based upon new Census Bureau figures and issued by the National Highway Users Conference. The statement, transmitted to federal and state officials, shows 383,347 of the 2,133,437 wholesale, retail and service establishments operating in the United States in 1933 relied entirely upon sales to owners and operators of motor vehicles.

Analysis of the government figures also develops the following facts:

Of the total payroll of $5,058,803,000 for all wholesale, retail and service trades, $801,006,000, or 15.9 per cent, accrued from automotive, petroleum, tire and allied trades.

Automobile owners and operators, when buying from dealers who cater exclusively to their demands, make 13 per cent—or $7,839,025,000—of the dollar-volume purchases recorded by the nation's commercial and service establishments.

Firms making automotive and allied sales exclusively have 655,012 full-time employees and provide part-time employment for 101,137 persons.

The census of firms making automotive sales exclusively includes the following totals: wholesalers of automotive products, 6,303; wholesalers of petroleum and its products, 28,421; retail motor vehicle dealers, 30,646; retail dealers in accessories, tires and batteries, 16,027, and filling stations, 170,404.

The totals do not include figures covering highway construction and maintenance, automobile production, petroleum production, motor bus driving, inter-city truck driving and other activities of similar character. It is pointed out, also, that they do not include corresponding figures for industries which supply materials. Neither do the totals reflect automotive business of firms with major interests in other fields.

The business, wage and employment totals in the statement are cited by Roy F. Britton, Director of the National Highway Users Conference, as indicating the degree to which sales to automobile owners and operators have reduced the impact of the depression.

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Snow Removal in Pennsylvania

During the winter of 1933-34 the snow removal program of the Pennsylvania State Highway Department included 11,839 miles on the old system, in addition to which the most important routes on the rural system were cleared of snow.

The total cost of snow removal, exclusive of overhead, for each of the following winters was: $1,163,600 for 1929-30; $1,518,977 for 1930-31; $1,367,074 for 1931-32; $1,207,762 for 1932-33. The winter of 1933-44 was unusually severe and as a result the total cost of snow removal operations was $2,388,000, of which $546,400 was spent on the rural system. Even this unusual cost represented only about $1.43 per registered motor vehicle to avoid extensive losses of highway facilities during the winter months. Maintenance forces are ordered out day or night for cindering as soon as ice begins to form, and snow removal starts as soon as the fall reaches a depth of 2 ins. The amount of snow fence erected last fall to protect the highways from drifts amounted to more than seven and one-half million feet.

THE REFLECTING

Their Influence on the Night Visibility of Highway Bridges

By D. L. GAMBLE

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IT IS generally agreed that white and light colored paints possess a very high efficiency in rendering highway markers visible by night. That bright paints produce better night visibility than dark paints can be readily demonstrated. A bridge, for instance, at night is made visible to a driver in an approaching automobile primarily by means of light from the headlights which has been reflected back along the road by the exposed surfaces of the bridge structure. All other conditions being equal, the more light reflecting power these surfaces have, the greater will be the quantity of light turned back in the direction of the approaching car. As a natural result, the driver will be able not only to see the structure distinctly at greater distances but the bridge will also stand out with greater visibility as he approaches because of the more marked contrast the illuminated members will make with the surrounding darkness. Ordinarily paints produce films that exhibit essentially pure diffuse reflection; that is, they tend to reflect light more or less equally in all directions regardless of how illuminated. In this case a white paint having a reflecting power of 85 per cent will prove much more efficient than a black which will reflect only 10 to 20 per cent of the incident light. In a series of such paints, varying from white-to-black, the relative efficiencies would be more or less proportional to the diffuse reflecting powers.

Conditions Affecting Night Visibility—The degree of night visibility which a paint is capable of imparting to a bridge, under the conditions of illumination and viewing which exist on a highway, depends not only on the total reflecting power of the paint film, but is also influenced to quite a degree by the manner in which the light is reflected by the painted surfaces. As pointed out above, the ordinary types of paint produce films which reflect diffusedly, exhibiting relatively little specular or mirror-like reflection. These paints, when illuminated from one direction, as with headlights, distribute the reflected light more or less equally in all directions. Certain paints composed of polished metallic flakes exhibit a very high degree of specular reflection. This is due to the "leafing" or tendency of the flakes to orient themselves parallel to the film surface and thus contribute

Influence of Reflecting Characteristics of

From Top to Bottom: Figs. 1-5.—Fig. 1.—White—Direct Approach. White has the highest diffuse light reflection value of all the colors and, therefore, gives the best visibility. Light striking a white or light tint surface is distributed in all directions. Fig. 2.—White—Side Approach. Where the painted surface is not perpendicular to a light source it is essential to have high light diffusing paint to provide good visibility. Contrast this photograph wth Fig. 10, which is a paint low in diffuse reflection value. Fig. 3.—Light Gray—Direct Approach. Light gray rates well up in the list of high light reflecting tints. Visibility is good and approaches white. Fig. 4.—Light Gray—Side Approach. Because of the intensity of the light there appears to be little difference between white and light gray where the light is focused, but note the lower brightness of the entire model. Fig. 5.—Dark Gray—Direct Approach. Dark colors absorb light and provide little night visibility.

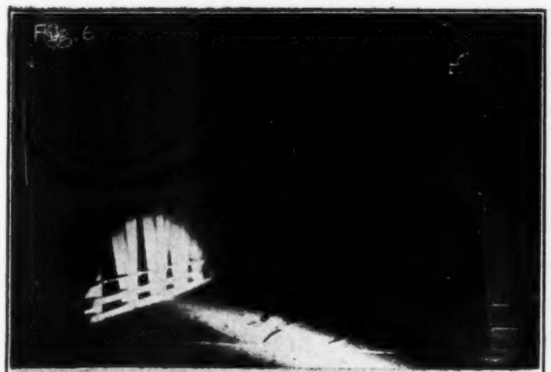
CHARACTERISTICS OF PAINTS

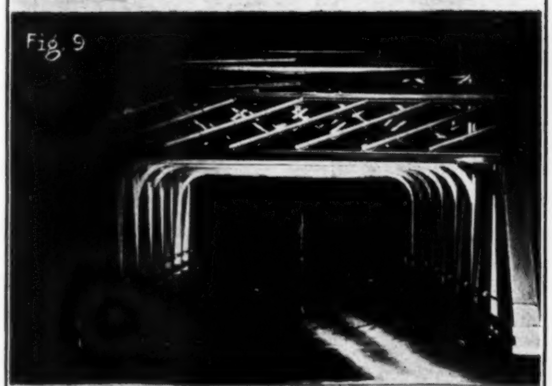
a considerable amount of "metallic" or specular reflection. When such a film is illuminated from one direction, a great portion of the reflected light is concentrated into a relatively small solid angle having an angular direction equal and opposite to that of the incident beam (angle of direct or specular reflection). The first type of paint (diffuse reflection) when illuminated in a given direction can be seen equally well from almost any angle of view. The second type (specular reflection) suffers greatly in visibility when viewed from any angle but that of direct reflection. When viewed in the direction of direct or specular reflection, the metallic luster paint may appear as bright as an ordinary white paint but at any other angle of view it will appear very much darker.

Experiments with Bridge Model—In order to demonstrate the influences of some of the factors discussed above on the night visibility of a highway bridge, some experiments were carried out with a miniature bridge model designed after a typical highway bridge. A small eight-volt spotlight of constant intensity was made to serve as a source of light. This light carried a double filament bulb and was so focused as to produce two separate beams of light, thus simulating the headlights of an automobile. The relative visibilities, when the bridge was painted with different materials and illuminated in various ways, were recorded photographically. In order to standardize conditions as much as possible, the same exposure and development times were used in all cases. It is realized, of course, that the relative visibilities, as recorded photographically, cannot be taken as exact reproductions of the eye visibilities because of the failure of the densities and contrasts on the photographic plates to follow exactly the reciprocity law. This is the case in the comparison of the white and black paints. However, in the cases of the white, gray and metallic paints it is felt that the photographs closely reproduce the actual eye visibilities.

Paints Used in Tests—The bridge was painted with the materials listed below and photographs taken under two different conditions of illumination. In each case the spotlight and camera were so placed as to simulate as nearly as possible the relative positions of the headlights and the eye of a driver of an automobile. One set of photographs represents a more or less direct approach

Paints on the Night Visibility of Highway Bridges



From Top to Bottom: Figs. 6-10.—Dark Gray—Side Approach. Only because of the intensity of the light does the spot look bright. General visibility is very poor. Fig. 7.—Black—Direct Approach. Black absorbs practically all the light thrown upon it and cannot be considered in night visibility. Fig. 8.—Black—Side Approach. Even the high intensity of the light fails to show anything but a mere outline of the rail to the model. Fig. 9.—Metallic Luster Gray—Direct Approach. Metallic surfaces have high specular (mirror) reflection and give spotty visibility. Bright portions of the model are perpendicular to the light source; direct, shaded portions are not. Compare with figure showing a paint of high diffuse reflection. Fig. 10.—Metallic Luster Gray—Side Approach. Notice the rivet heads in the upright member at the right. Because of their shape a small part of each is perpendicular to the light source. The flat surface of the member, however, receives light at an angle and has poor visibility.

to the bridge while the other set represents an approach from an angle such as might be encountered where the highway leading to the bridge is curved.

PAINTS USED

Paint	Total Reflection Factor (Includes both Specular and Diffuse)
White	0.88
Dark Gray	0.35
Black	0.15
Light Gray	0.68
Metallic Luster Paint	0.68

Photographs, Figs. 1 to 8, demonstrate the effect on the night visibility of the total reflectance of the paint applied, the reflecting characteristics being kept as nearly identical as possible. Photographs Figs. 2, 4, 9 and 10 permit a comparison of two paints having the same total reflectance but differing greatly in reflection characteristics. Photographs Figs. 9 and 10 represent a metallic luster paint having a total reflectance of 0.68 while Photographs Figs. 2 and 4 represent an ordinary gray paint prepared so as to have the same total reflectances as the metallic paint. It will be noted, in the case of the metallic paint, that only those members of the bridge model which are capable of turning the directly reflected beam back into the camera appear bright. The surfaces which direct the specular light away from the camera lens exhibit poor visibility because of the relatively feeble diffuse reflection. In the case of the diffusing paint, all illuminated members stand out equally well.

Photographs Figs. 1, 2, 9 and 10 demonstrate the advantages of a white diffusing paint over a typical metallic luster paint as a means of improving the general night visibility.

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Cost of Sand Blasting and Bridge Painting

The sand blasting, painting and repair of the major steel structures on the state highway system of California has been done by a special traveling bridge crew for the past several years. This crew transfers from district to district as the need develops. T. H. Dennis, State Maintenance Engineer, gives the following data on the work of this crew in the recently issued 9th Biennial Report of the Division of Highways.

During the period July, 1932, to June, 1934, bridges have been cleaned, painted and repaired by this crew, in the following districts:

District	No. of Bridges	Cost
I	11	$25,855.75
II	3	5,552.62
III	1	2,156.42
IV	5	4,995.41
V	10	38,737.60
X	3	18,840.09
Totals	33	$96,137.89

The regular crew consists of the following men:

1 superintendent.
1 leading man.
1 equipment operator.
2 carpenter helpers.
4 carpenter painters.
4 highway road laborers.

Additional labor which may be required is obtained in the locality of the work.

The following equipment is assigned to this crew:

	Monthly rental
1 Ford express	$ 33.75
1 Ford Tudor	42.50
1 Dodge truck, 3-ton	116.25
1 Trailer	11.25
1 Compressor—160 cubic feet	56.00
1 Compressor—360 cubic feet	125.00
3 Sand chambers—7½ cubic feet	90.00
1 Pressure feed paint tank, 7 gal	None
3 Pressure feed paint tanks, 10 gal	None
8 Paint spray guns	None
1 Riveting air hammer	None
Total monthly rental	$474.75

Miscellaneous small tools, sand and air hose, paint hose, rope, falls, etc., are all carried in the truck.

The most expensive item of work in the maintenance of steel structures is the sand blasting. Progress made and cost of the work depends on the quality of the sand, efficiency of nozzles, power plant, equipment, and operators. The design and accessibility of the structure, condition of the steel and weather conditions, must also be considered.

SUMMARY OF QUANTITIES AND COST OF BRIDGE PAINTING, 1932-34 AND 1930-32 FOR COMPARISON

1932-34—
33 bridges = 15,167 lineal feet.
Roadway area = 301,620.5 sq. feet.

Class of Work	Square feet	Gallons paint	Tons sand	Square feet per ton	Square feet per gallon	Unit cost	Total cost	Per cent of total	Cost comparison with 1930-32: Per cent decrease	Per cent increase
1. Clean and spot paint	34,630	77	....	....	450	$0.115	$ 3,993.97	4.16	...	14
2. Sand blasting	353,137	....	1,755.74	201	....	x0.135	47,752.62	46.69	35	....
3. Prime coat	359,837	784.25	....	....	459	x0.028	9,924.71	10.33	18	....
4. Second coat	368,555	700	....	....	526	x0.023	8,439.84	8.78	12	....
5. Third coat	756,115	1,760	....	....	430	x0.0214	16,198.65	16.86	21	....
6. Steel guard rail	22,366	88	....	....	254	0.046	1,026.15	1.07	...	....
7. Wood guard rail and wheel guard	91,197	337	....	....	270	0.019	1,746.33	1.82	...	....
8. Concrete curb	4,093	20	....	....	167	0.037	149.73	0.15	...	....
9. Miscellaneous repairs	....	....	....	....	....	....	6,855.89	7.14	...	....
						x$0.2074	$96,087.89	100	29.5	
1930-32										
1. Clean	41,700	....	....	....	....	$0.015	$ 644.68	....	...	....
2. Clean and spot paint	101,475	274	....	....	370	0.101	10,271.34	....	...	....
3. Sand blast steel	171,010	....	1,191.5	144	....	x0.207	35,410.00	....	...	....
4. Sand blast concrete	8,500	....	7.0	1,214	....	0.015	130.73	....	...	....
5 Paint prime coat	171,010	558	....	....	308	x0.034	5,936.00	....	...	....
6. Paint second coat	60,600	108	....	....	561	x0.026	1,609.62	....	...	....
7. Paint third coat	725,765	2,404	....	....	301	x0.027	20,198.38	....	...	....
8. Paint guard rail	75,795	202	....	....	376	0.013	1,024.72	....	...	....
9. Paint sidewalk	46,200	90	....	....	513	0.007	326.47	....	...	....
10. Repairs	....	....	....	....						
						x0.294	$79,449.18			

Only items "x" checked are included in total for unit cost.

VEHICLE POWER REQUIREMENTS As Affected by Roadway Surface

New Measurements Permit Closer Solution of Highway Problems

(Concluded from December issue)

ANALYSIS of Tractive Resistance.—"Before presenting the results of tests on different road surfaces, a detailed analysis of tractive resistance on a smooth concrete road surface at an air temperature of 70° F. will be presented. The basis for determining rolling resistance has already been explained as has also the procedure for determining total resistance. The difference between these two values at any given speed may obviously be considered as air resistance."

Total Resistance.—"The customary test procedure was used in determining the power needed to drive the car at the required speeds (Fig. 3). The values indicated by the horsepower curve of Fig. 3 are readily converted into values of total resistance in pounds by using formula [1.]. The values of total rolling plus air resistance thus calculated are shown by the upper curve of Fig. 4. Attention should be called to the close agreement between the values given by these measurements and those obtained by coasting down 1-, 2-, and 3-per cent grades. It should be noted that these values have been corrected, in so far as is possible, for wind and temperature variations."

Rolling Resistance.—"The power used in overcoming rolling resistance on this concrete surface was determined by applying the efficiency curves of Fig. 5 to the

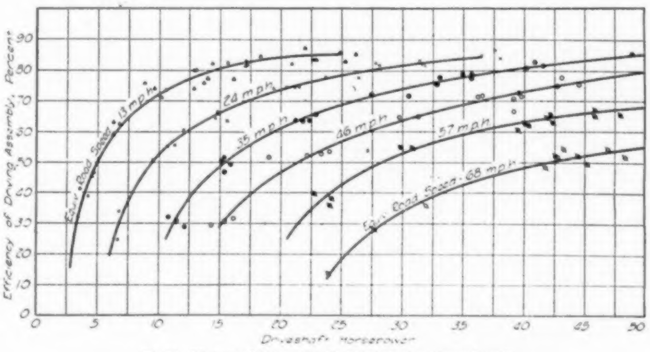

Fig. 5.—Efficiency of Driving Assembly of Test Car at Various Road Speeds.

power values already given. These efficiency curves are based on the results of a laboratory calibration so it is assumed that the rolling resistance is the same in both the laboratory calibration and the road tests under consideration. The results of applying these efficiency curves is reflected in the rolling resistance curve of Fig. 6, which has the equation,

$$R_R = 45.0 + 3.19V^{0.676} \qquad [2.]$$

"The fact that the rolling resistance has been determined by applying the efficiency curves to values of total resistance secured in road tests should be emphasized. Measurements of rolling resistance are usually made by setting up the vehicle to be tested on the dynamometer, using the dynamometer as a motor, and measuring the power required to turn the wheels of the car. In the present case, the drums were driven by the wheels of the test car just as the car is driven forward by the wheels on the road, and the power delivered by the wheels was measured. With the exception of air resistance, all of the forces acting on a motor vehicle on the road were thus present during the dynamometer test and it seems reasonable to believe that the values of rolling resistance thus secured are more nearly correct than would otherwise be obtained.

"There are reasons to believe that this equation represents, to a fair degree, the actual magnitude of rolling resistance for this test car. One indication of the probable correctness of the values given by the expression is noted in the close agreement between certain of these values and those obtained by towing the vehicle at low speeds. Rolling resistance curves of the same general shape were secured in tests on a truck at Purdue University."

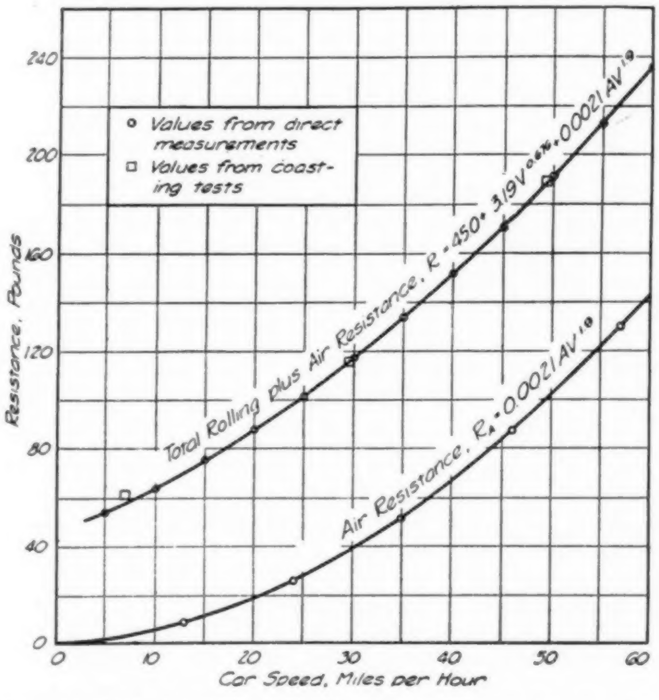

Fig. 4.—Analysis of Tractive Resistance on a Level, Smooth Concrete Road Surface at an Air Temperature of 70° F.

Air Resistance.—"Since the total rolling plus air resistance is known and the magnitude of rolling resistance is indicated, the difference between these two values

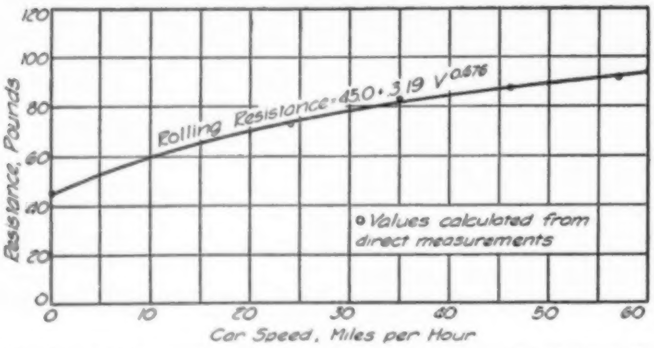

Fig. 6.—Rolling Resistance of the Test Car on a Level, Smooth Concrete Road Surface at an Air Temperature of 70° F.

will give the air resistance at a given speed. Fig. 4 shows total air resistance thus calculated."

"In establishing the correctness of this value, it is well to consider the data from which it has been derived. It has already been indicated that the values of total rolling plus air resistance are checked by the results of coasting tests (Figs. 3 and 4). These values are also verified by the curves (not shown here), where the values in question have been used as a basis for calculating total resistance on grades. As a result, there is an almost exact agreement between the observed and calculated values.

"The values of rolling resistance depend upon the results of the dynamometer tests, and of all the data used, these are most open to question. However, even these values are checked at the lower speeds by the results of towing tests. An additional check on the magnitude of rolling resistance at a speed of practically zero miles per hour is given by the results of deceleration tests."

Classification of Road Surfaces.—"Road surfaces have heretofore* been classified into three groups—high, intermediate, and low—apparently based on first cost alone and evidently made without regard to the effects of these surfaces on motor vehicle operating costs. Tests on a variety of road surfaces so clearly show the effects of these surfaces on automobile operation that a new classification is needed. The following reclassification into five classes is made.

Class I. Rigid, stable, pavement surfaces constructed, and perhaps designed, to carry and withstand the effects of heavy traffic. These *heavy-duty* pavements are *not* subject to changes in surface characteristics because of variations in climatic conditions. Included in this classification are: portland cement concrete, brick, asphalt plank, asphalt block, wood block, granite block, and other block surfaces, sheet asphalt, asphaltic concrete, and such bituminous or other surfaces, as meet the above requirements.

Class II. Fine-textured, semirigid, medium-duty treated surfaces not designed nor constructed to carry and withstand the effects of heavy traffic without deformation of the surface. Included in this classification are certain bituminous macadams, low-cost bituminous surfaces or surface treatments, oil mats, treated gravels, retreads, and other surfaces of a like nature. These surfaces may or may not be affected by climatic conditions.

Class III. Same as class II except that the surface is open-grained and of a very coarse so-called nonskid texture, conducive to excessive tire wear.

Class IV. Light-duty untreated surfaces, such as sand-clay, gravel and macadam, that are characterized by loose surface material, unevenness in the surface, and changes caused by climatic conditions.

Class V. Natural soil or earth roads which are practically impassable under certain climatic conditions.

In the foregoing classification of surfaces, variations in the conditions of those surfaces within a given class whether due to wear or climatic conditions have not been

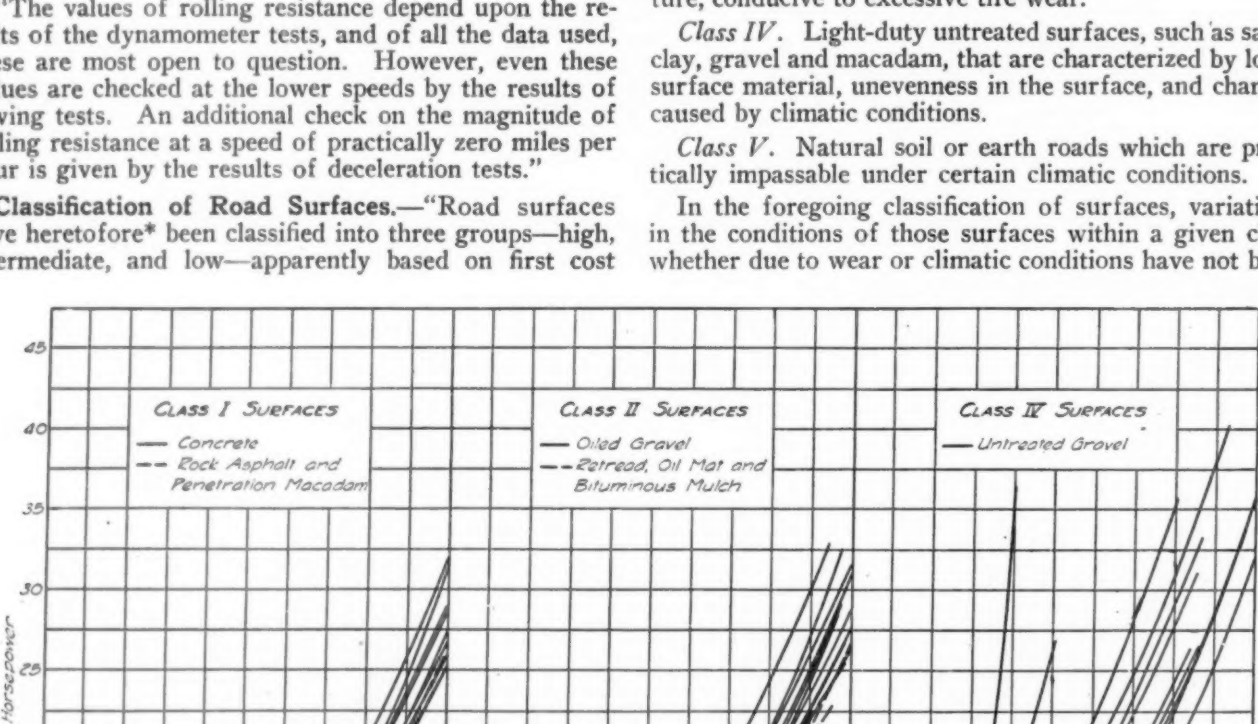

Fig. 7.—Power Requirements on Various Classes of Road Surfaces. Temperatures Ranging from 21° to 87° F.

TABLE 1.—DRIVESHAFT HORSEPOWER REQUIREMENTS CORRECTED TO 70° F.

No.	Car Speed, Miles Per Hour 10	15	20	25	30	35	40	45	50	Condition of Surface
				Concrete surfaces, class I						
1	1.3	2.8	4.3	6.6	9.6	12.4	16.1	20.7	24.9	Good
2	1.6	3.2	4.8	7.0	9.5	12.1	15.6	20.4	25.9	Good
3	1.4	2.8	4.6	6.8	9.7	12.6	16.3	20.8	26.4	Good
4	1.3	2.6	4.2	6.4	9.0	12.0	15.3	19.1	23.9	Good
5	1.5	2.8	4.6	6.8	9.5	12.3	16.1	20.5	25.6	Good
6	1.5	3.0	4.6	6.8	9.1	11.8	15.4	20.3	26.0	Good
7	1.6	3.1	4.8	7.0	9.6	12.5	15.8	20.0	26.0	Good
8	1.8	3.5	5.4	7.8	10.6	13.7	17.4	22.1	27.5	Raining, pavement wet
9	1.8	3.5	5.2	7.3	10.0	12.9	16.4	21.1	26.3	Good
10	1.7	3.1	4.7	6.8	9.5	12.4	16.1	20.6	25.4	Good
11	1.5	3.1	4.8	7.0	9.6	12.5	18.2	21.1	27.2	Rough pavement
				Bituminous surfaces, class I						
12	1.7	3.2	5.0	7.4	9.9	12.7	16.1	19.9	24.4	Smooth, excellent condition
13	2.0	3.5	5.7	8.0	10.7	14.0	17.9	22.7	28.7	Soft seal coat
				Bituminous surfaces, class II						
14	2.1	3.7	5.6	7.8	10.3	13.2	16.7	21.1	26.8	Uncompacted, open surface
15	2.3	3.9	6.0	8.2	10.8	13.7	17.3	21.8	27.3	Well compacted, smooth
16	2.2	4.0	6.1	8.6	11.5	15.0	18.9	23.2	28.3	Open, rough textured
17	2.2	4.0	6.0	8.4	11.2	14.6	18.5	22.8	...	Smooth, coarse textured
				Bituminous treated gravel surfaces class II						
18	2.3	4.0	6.1	8.5	11.6	14.4	18.2	23.2	29.5	Fair condition
19	2.2	3.8	5.8	8.3	11.3	14.5	18.3	23.3	29.3	Good condition
20	1.6	3.1	4.8	7.2	9.9	13.0	17.0	21.5	26.5	Good condition
21	2.1	3.8	5.6	8.0	10.6	13.6	17.5	22.6	29.8	Good condition
22	2.4	4.1	6.1	8.7	11.9	15.6	20.0	25.0	30.5	Good condition
23	3.7	5.9	8.3	11.4	14.8	18.8	23.7	30.1	...	Rough, poor condition
24	4.6	7.5	10.8	14.2	18.5	22.0	26.0	30.2	...	Rough, poor condition
25	2.0	3.7	5.8	8.4	11.5	15.3	19.5	24.9	31.1	Good condition
26	2.0	3.6	5.7	8.1	11.0	14.3	19.7	23.1	28.1	Good condition
27	2.4	4.1	6.2	8.6	11.3	14.4	18.2	23.2	28.9	Good condition
				Untreated gravel surfaces, class IV						
28	2.0	3.8	5.8	8.5	11.8	15.1	19.3	...	...	Frozen fair condition
29	2.2	4.0	6.2	9.0	12.4	16.0	20.4	...	...	Frozen, rough
30	4.4	7.5	10.9	14.7	19.9	22.9	28.5	35.2	...	Wet, packed surface
31	2.5	4.6	7.0	10.1	13.8	18.0	22.6	...	...	Soft, cut up
32	5.8	8.9	12.2	16.3	21.3	27.2	34.0	...	...	Soft, loose surface
33	4.1	6.6	9.3	12.2	16.7	21.5	26.8	...	...	Wet, rough
34	4.2	6.7	9.7	13.2	17.6	22.7	28.4	...	...	Wet, very rough
35	6.7	10.6	17.2	26.0	...	...	...	...	...	Wet, very soft
36	6.7	13.9	34.9	...	...	...	...	...	...	Wet, very soft
37	2.8	4.4	6.5	9.1	12.5	16.7	21.9	28.3	35.6	Wet, well packed
38	2.5	4.3	6.3	8.8	11.7	15.2	19.5	25.2	32.1	Dry, good condition
39	2.3	4.2	6.3	8.9	12.0	15.6	19.5	24.0	...	Dry, good condition

considered. A class I surface, for instance, is any surface meeting the requirements for this class regardless of whether it is in good, fair, or poor condition. Under certain conditions weather may affect class II surfaces considerably. It is to be expected, therefore, that there will be a wide variation in the range of power requirements for the surfaces within a given class."

Effect of Road Surface on Power Requirements.—"Good, far and poor surfaces in classes I, II, IV, and V were tested under different climatic conditions. The complete list of surfaces tested includes concrete, rock, asphalt, penetration macadam, road oil mat, bituminous mulch, bituminous treated gravel, oil treated gravel, tar treated gravel, plain gravel, and ordinary earth.

"Table 1 shows the power required to drive the test car at given speeds over road surfaces in different conditions. The values given in this table were secured by correcting the original data (Fig. 7), to a temperature of 70° F. The temperature corrections were made by determining the change in horsepower requirements per degree of temperature at a given speed from the curves (not reproduced here), and then applying these values to the data to be corrected. All tests were made in the absence of wind; the differences, therefore, may be attributed almost entirely to surface conditions."

Effect of Road Surface on Gasoline Consumption.—"Gasoline consumption records for the power tests shown in Fig. 7 are represented graphically in Fig. 8. A careful study of the records of power requirements and gasoline consumption indicates that the uniformity found in the former does not, in general, carry through to the latter. Some indication of the number of variable factors entering into a determination of power requirements has already been given; in the case of gasoline consumption measurements, such additional variables as engine temperature, air density, barometric pressure, and relative humidity enter. For these reasons, there seems to be a logical argument for using the results of the power tests as a basis for determining the relative efficiency of operation on various types of roads."

Effect of Road Surface on Tractive Resistance.—"In general, tractive resistance is affected by road surface conditions in the same manner as are power requirements, since the one is calculated from the other. Rather than again present the facts thus brought out in the power curves of Fig. 7, it will suffice to give typical values of tractive resistance on a few representative surfaces. The surfaces chosen are smooth concrete, gravel in good condition, bituminous treated gravel in poor condition, plain gravel in poor condition, and very light gravel in a soft, muddy condition. The resistances experienced by the test car when traveling over these surfaces are clearly shown in Fig. 9; the values of resistance here are expressed per ton of vehicle weight. Typical values taken from these curves show that the resistance encountered by the test car on a smooth concrete pavement ranges from about 14 pounds per ton at a speed of 1 mile per

*T. R. Agg and H. S. Carter, "Operating Cost Statistics of Automobiles," 1929.

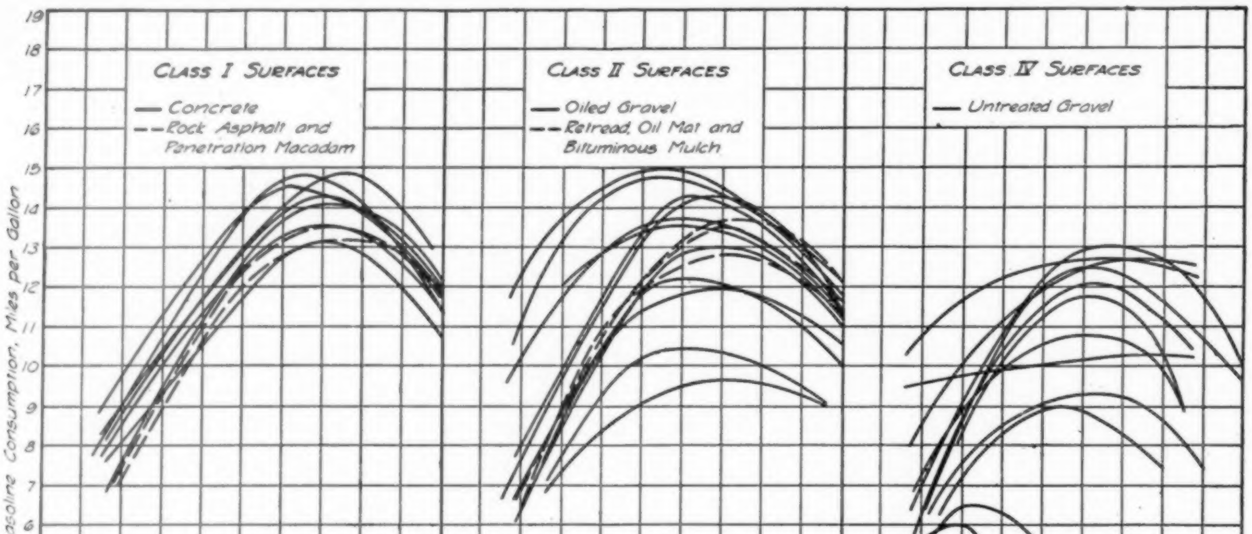

Fig. 8.—Gasoline Consumption on Various Classes of Road Surfaces.

hour to 33 pounds per ton at 25 miles per hour. The resistance at 50 miles per hour is 63 pounds per ton which is double that at 25 miles per hour and over 4 times that at a speed of 1 mile per hour. For an untreated gravel surface in good condition, the resistances on the average are about 8 pounds per ton higher than those on concrete.

"Bituminous treated gravel, while ordinarily a good surface, may be in so poor a condition as to give a resistance of 40 pounds per ton at a very low speed to 90 pounds per ton at 50 miles per hour. Untreated gravel surfaces in poor condition give correspondingly higher values, but when in a soft and muddy condition, give values of tractive resistance equal to 60 pounds per ton at low speeds and over 200 pounds per ton at a speed of only 20 miles per hour."

Summary.—"The significance of the foregoing tabulations of power requirements, gasoline consumption, and tractive resistance on various road surfaces is shown in Fig. 10 for a speed of 40 miles per hour at an air temperature of 70° F. For reasons that have been discussed, the horsepower values given in Table 1 are used to bring out the differences due to surface condition.

"In the upper part of Fig. 10, the surfaces are arranged in accordance with both their classification and the magnitude of the power values within a given class. For class I surfaces, the range of power values is small—from a minimum of 15.3 horsepower to a maximum of 18.2 horsepower. It should be noted, however, that some of the values for class II surfaces are lower than the latter figure, ranging as they do from 16.7 horsepower to 26.0 horsepower. The power values for class IV surfaces range from 19.3 horsepower for the best condition to 32.6 horsepower and higher for the worst condition. Again, the value of 19.3 horsepower is considerably less than the maximum for class II and III surfaces. Obviously, there is no definite succession of bands of power values to which surfaces of any class can be assigned.

"In the lower part of Fig. 10, the power values at 40 miles per hour have been plotted in accordance with their magnitudes and without regard to the road surface classification. This figure shows clearly that the relative efficiencies of road surfaces vary widely. As used in this discussion, surface efficiency for a given road surface may be defined as the ratio between the power requirements on a smooth, hard, unyielding surface and those on the given surface. A surface such as smooth

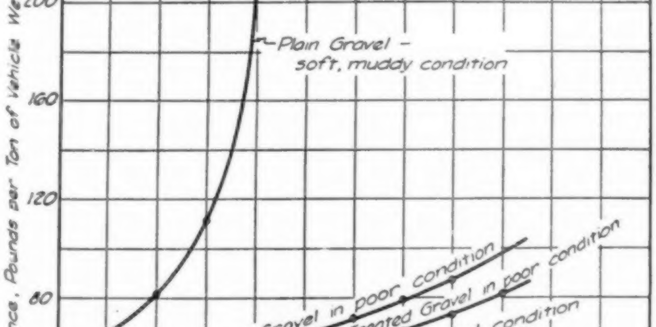

Fig. 9.—Rolling Plus Air Resistance of the Test Car in Pounds per Ton of Vehicle Weight for Various Types of Road Surfaces.

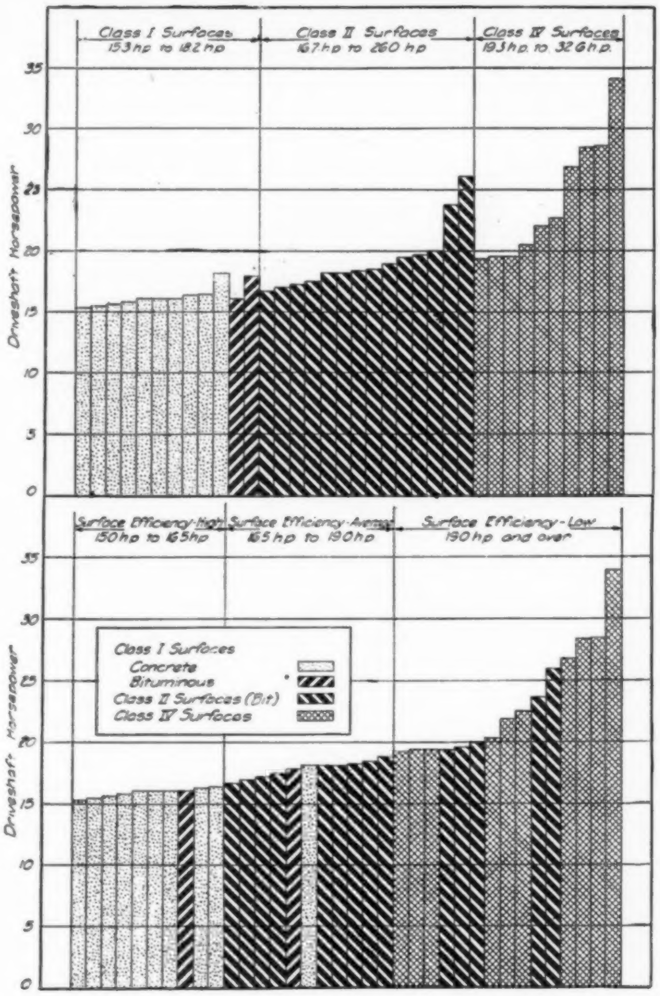

Fig. 10.—Power Requirements (Corrected to 70° F. Air Temperature) of the Test Car at 40 Miles per Hour on the Road Surfaces Tested.

concrete would be highly efficient; a soft, yielding surface, on the other hand, would be very inefficient.

"Further study will show that there is one group of highly efficient surfaces, another whose surface efficiency is average, and another that is very inefficient. Suggested horsepower values for these three groups for the test car are:

High surface efficiency—15.0 to 16.5 horsepower.
Average surface efficiency—16.5 to 19.0 horsepower.
Low surface efficiency—19.0 horsepower and over.

"No one class of surfaces can be said to have either a high, average or low efficiency because of the effect of differences in the surface condition. A class I surface will usually be highly efficient, but this efficiency may drop to an average value if the surface is in poor condition. This applies equally to both concrete and bituminous surfaces. A class II or III surface may have either a high, average, or low efficiency, depending upon its condition. For the most part, they may be said to have an average surface efficiency. Class IV surfaces, in general, will have an efficiency that ranges from average for the best surface condition to low for the worst condition.

"Again it should be noted that the values just given and the statements made are for the test car only and are not generally applicable to all vehicles. The relative effect of road surfaces upon motor vehicle operation would probably be the same as that given above, but an extensive research with a large number of vehicles would be needed before this could be proven."

Impact Resistance.—"Impact resistance has already been defined as the retarding force due to irregularities of the road surface. Such irregularities cause a change in the relative distortion of tire and road surface and, for the same vehicle speed, give a different value of resistance from that obtained on a smooth surface.

"The fact that impact resistance is very definitely a part of tractive resistance and, as such, is measurable is very clearly brought out in Figs. 11 and 12. Fig. 11 represents the results of tests on a rough concrete pavement; it will be noted that the increase in resistance due to impact is not appreciable until a speed of about 50 miles per hour is reached. The upper curve in this diagram represents the total resistance. The values of air resistance and rolling resistance for smooth concrete are substracted from the total measured resistance, the remainder then represents resistance due to impact.

"Fig. 12 illustrates the effects of roughness and softness of a gravel road on resistance. The upper curve again represents total resistance. Air resistance is then subtracted as is also the rolling resistance for smooth concrete. The rolling resistance curve for this gravel surface in a soft but not rough condition was not available. Hence, the rolling resistance curve for concrete was used to bring out the effects of softness and roughness of the gravel surface."

Temperature Effects.—A series of test runs at 9 different speeds ranging from 10 to 50 miles per hour, and at temperatures ranging from 21° to 70° F., indicates that power requirements are considerably affected by air temperature. Plots of these tests indicate that temperature effects increase with speed; and that at 50

Fig. 11.—Analysis of Tractive Resistance on a Rough Concrete Pavement.

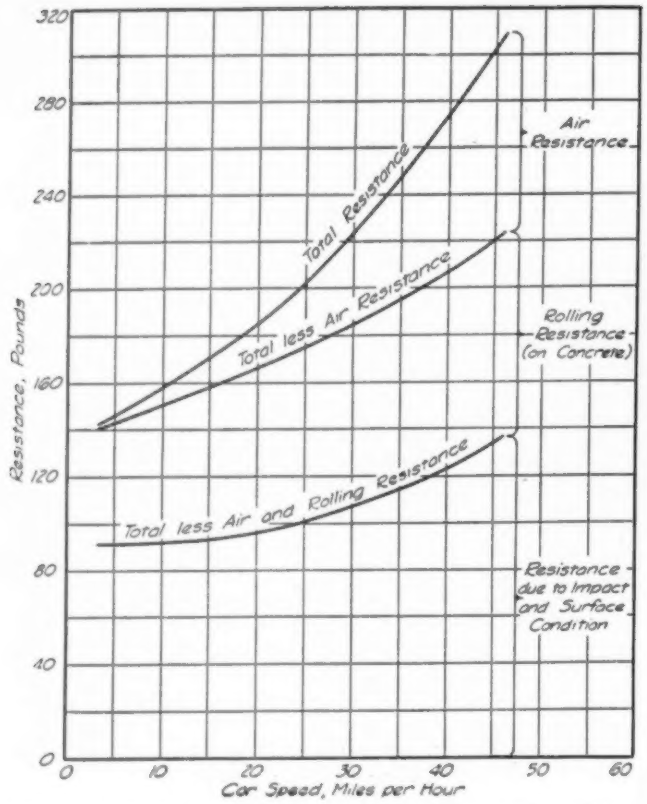

Fig. 12.—Analysis of Tractive Resistance on a Wet, Soft, and Very Rough Gravel Road.

miles per hour, each one degree drop in temperature is accompanied by approximately a one pound increase in total resistance.

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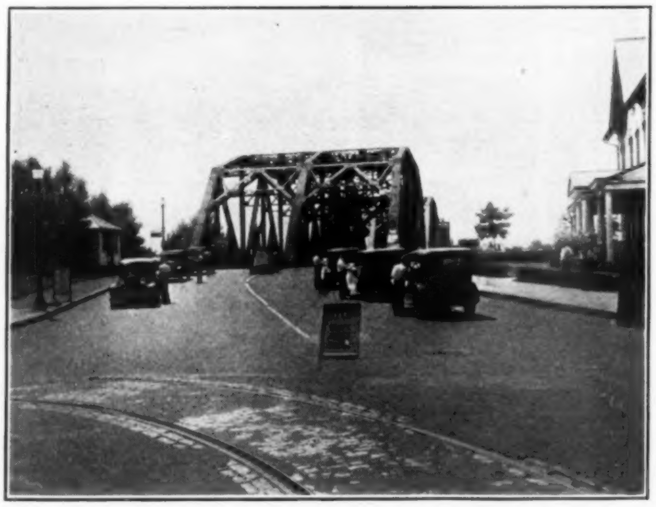
Traffic Surveys by U. S. Bureau of Public Roads

Traffic surveys recently completed or nearing completion by the U. S. Bureau of Public Roads are located in the Washington, D. C., Regional Area, Indiana, New Jersey, Florida, Connecticut, and Arkansas. These will be covered, each in a special report.

On Florida State Road 140 Entering Miami Beach. Photograph Taken in Mid-Winter. Operator at Work Recording Motor Vehicle Traffic Density



New Jersey End of Lower Bridge Across Delaware River at Trenton on U. S. No. 1. Traffic Recorders Obtaining Origin and Destination of Interstate Traffic

Regarding the survey in Washington, New Jersey, and Florida, the annual report of the Chief of the Bureau gives the following:

Washington.—Detailed recommendations with regard to proposed new routes and bridges are a part of the report, and data with regard to present volume of traffic, the type and composition of this traffic, and studies of its normal movement are also presented. This material will be found useful in the study of numerous problems which are not touched upon in the report itself. Large savings in right-of-way and construction costs should be realized from the detailed data and recommendations resulting from the survey.

New Jersey.—The report will contain data with regard to the origin and destination of truck traffic, the nominal capacities and body types of trucks, their classification as owner-operated, contract haulers, or common carriers, and as of interstate or intrastate operation, the origin and destination of all vehicles observed at the Hudson Delaware River crossings, and the determination of passenger-car traffic upon each of the highway systems which is local to each county or which originates in other areas.

Florida.—This project is to obtain complete data with regard to present use of the State highway system. At certain major points in the citrus area, the volume and movement of citrus-hauling trucks will be studied. Complete analysis of the volume and movement of tourist traffic, together with detailed data with regard to their expenditures, speed of travel, purpose in visiting Florida, length of stay, and areas of origin, are a part of the survey.

▼

Southwest Road Show and School—The 8th annual Southwest Road Show and School will be held March 5-8 in the Coliseum at Wichita, Kan., under the direction of the Wichita Thresher and Tractor Club, Inc. In connection there will be an exposition of equipment and material used in the highway field. More than 4 acres of housed space are available for exhibition purposes.

The Good Roads School will be directed and supervised by such interested organizations as the Kansas State Highway Commission and Engineering Department of Kansas State College of Agriculture, cooperating with state and federal highway engineers; United States Bureau of Public Roads, colleges and universities.

THE ENGINEER'S NEED OF TRAFFIC SURVEY DATA

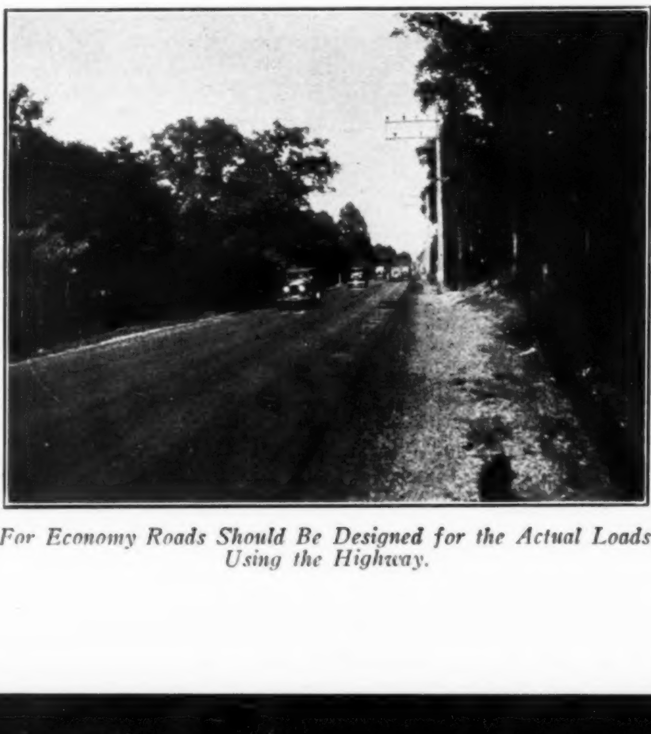
By E. C. WENGER
Regional Highway Engineer, Portland Cement Association

THE increasing popularity of traffic surveys is evidenced by the number of such studies undertaken during the last few years by cities, counties and states. The need of such data in highway planning and its use in highway design is now generally recognized by highway engineers.

Ten years ago, most of our main through routes were in such a condition that the construction of any one road attracted traffic for a considerable distance. It was not uncommon for motorists to travel miles out of their regular routes to enjoy the comforts and benefits of a paved road. Almost any highway improvement could be justified by the traffic after its completion. The financing of highway construction was not difficult. If current funds were lacking, bond issues were voted. The number of miles constructed each year was governed largely by the equipment and materials available for such construction. To have advocated the collection of traffic data at that time for determining a rational plan of highway improvement would have had little popular support.

Today the situation is vastly different. While there are still many miles of highways in need of paving, the funds for such work are limited. The demand for highway improvements has not lessened but has increased. There is keen competition between communities for such needed improvements, and for the work such construction will bring to the unemployed of a community. The value of a rational plan of highway development extending several years into the future is rapidly gaining support. Such a program, to withstand adverse criticism must be based on the traffic importance of the highways as revealed by actual traffic surveys. Only by such a plan can highway engineers satisfy the various competing demands for highway improvement.

In addition to highway planning there are many other uses where traffic information can be profitably employed.



For Economy Roads Should Be Designed for the Actual Loads Using the Highway.

The Amount of Traffic Determines the Width of the Pavement Slab.

Among the most important is its value in pavement design. It has been common practice for a number of years to design a pavement slab for a superimposed load equal to the heaviest legal wheel load, with a factor of safety of two. It has long been known, from the fatigue behavior of concrete, that such a design will withstand unlimited repetitions of such loads and a limited number of even heavier loads without failure. Many rural roads and some city streets will either never be subjected to such loads or they will occur so infrequently that the fatigue limit of the concrete will not be reached within the life expectancy of the pavement. On such roads, if the pavement were designed for the legal wheel load, there would be a needless waste of funds.

With a knowledge of the number and weights of the various trucks and buses that will use the highway after construction, as determined from a traffic survey, it is possible to design a pavement slab for the predominating wheel loads, and calculate the life expectancy by evaluating the fatigue behavior of the concrete for the heavier wheel loads. By such a method the engineer can vary the cross section design to fit the particular loads of any highway. Real economy can be obtained in the design without any sacrifice of pavement life. Unless reliable and adequate traffic data are available, the engineer cannot take advantage of this opportunity for economy.

There has been a marked improvement in the design and construction of pavements during the last 15 years. New methods of proportioning concrete, change of cross section design, improvement in construction equipment and methods have all contributed to the quality of the present day pavements. Changes in design and specifications have been made only after exhaustive research and tests have proven such changes to be sound from an engineering standpoint. Engineers as a rule are loath to make changes or adopt new methods unless their value

has been proved. This explains why traffic surveys, which have long been advocated, have only recently become popular.

There are many good reasons why an engineer should undertake the collection of traffic information. Such data are as useful to him in the design of a specific improvement as are the field data necessary for the design of grades, alignment, and drainage structures in the preparation of road plans. The simplicity of the newly established principles of station selection, short counts and traffic approximations, make it possible for an engineer, unskilled in traffic surveys, to make a survey in a short time and at a small cost. In fact the time and cost of collecting traffic information for an entire county is not as great as that required for the collection of the necessary field data for the preparation of a few miles of road plans. The cost of an entire traffic survey may be saved in the possible economies in a single mile of pavement slab,—by the use of a design based on the actual loads using that highway.

"Time marches on." New methods and ideas are constantly being thrust on the engineer. No criticism can be directed against the engineer for failure to adopt new and untried methods. On the other hand the engineer should not stand in the way of his own progress by clinging to preconceived notions or individual prejudices. He should be the first to recommend and adopt those methods and ideas which can be useful to him and benefit his employer. Failure to do this will ultimately prove disastrous to him. Traffic survey data as an aid in rational highway planning and design are proving indispensable to the progressive highway engineer of today.

Book Reviews

Model Laws for Planning Cities, Counties and States.—This is the seventh volume of the Harvard City Planning Studies, and is made up of three reports under the foregoing general title. Authors: Edward M. Bassett, Frank B. Williams, Alfred Bettman, and Robert Whitten. Octavo, 137 pp. Harvard University Press, Cambridge, Mass. $2.50 postpaid.

Since the publication of the Standard Zoning and Planning Acts of the United States Department of Commerce, which were the first basic legislative forms for planning in this country, accumulated experience in their application has resulted in still further advances in city planning legislation. Circumstances have greatly changed in the meantime, however, and now there is need of a consistent set, or several different sets, of typical or model Acts, each based upon a single conception of the purpose in view, dealing with planning, zoning, subdivision regulation, and protection of mapped streets, applying to cities, counties, regions, and states, and inevitably bearing certain implications and suggestions even as to national planning.

The four authors of this volume, although agreeing as to the results to be sought, differ as to the methods which they consider to be desirable. Messrs. Bassett and Williams believe in submitting to our legislatures something already understood in principle and essentially familiar in use; Messrs. Bettman and Whitten prefer to give the techniques and procedures of planning more emphatic support in the structure and methods of legislation and of administration in local government.

Manual of Structural Design.—A book for everyday use by the structural engineer. Author, Jack Singleton, Consulting Engineer, New England Bldg., Topeka, Kansas. 216 pp., 7 x 10. Published by T. M. Ives & Sons, 415 Kansas avenue, Topeka, Kansas. $4.50 postpaid.

This book is not primarily a text book, nor is it merely a handbook. It is an original treatment of commonly accepted subject matter. Basic theories and formulas are developed into tabular form to eliminate the labor of computation as nearly as possible for any condition. The contents are in part as follows:

All types of concrete beams, for 2,000, 2,500 and 3,000 lb. concrete and for various stresses in reinforcing steel.

New, simple methods of designing shear reinforcement.

Various types of concrete joist.

Flat slabs.

Bending and direct stress, steel and concrete.

New concrete column tables, for various strengths concrete.

New, remarkably simple concrete footing design tables.

Concrete stairs.

Retaining walls.

New moment co-efficient data for beams.

Fireproofing.

Latest 1934 steel beams and columns, with all present types and sizes.

New bearing plate design data.

New plate girder tables, gross or net moment of inertia.

New steel column base slab tables.

Grillages.

Angle members, tension and compression.

S-Polygon design.

Torsion in steel beams.

New timber and wood design tables.

Suspension Bridges of Short Span—Author, F. H. Frankland. 128 pages—21 photo illustrations—34 cuts —6 tables. American Institute of Steel Construction, New York City; $3.50.

This book is an endeavor to furnish, in easily usable form, basic information on the design and construction of modern suspension bridges smaller in size than monumental structures such as the George Washington Bridge.

As the mystery is taken out of suspension bridge design any bridge engineer will find in this book all data necessary to make a complete design for suspension bridges of all types—with loaded or unloaded backstays, self-anchored or gravity-anchored, ordinary or multiple-span arrangements. The economics of continuous and hinged stiffening trusses, and fixed and hinged towers are covered, advantage being taken in the development of design formulas of the recent important advance in suspension bridge design brought about by the introduction of the generalized deflection theory.

Aesthetics and their relation to economics of design are fully discussed—a subject that is noticeable by its absence in most other books on the design of bridges.

The author treats at length of the proper attack on impact and its true relation to static and other dynamic forces. He explains his method—which has already been used in the design of several recently constructed bridges —of designing the entire cross section of the floor system and stiffening members as a unit to resist shear, bending moment, transverse wind, and compression when a self-anchored design is used. This method results in a high degree of economy and efficiency and has an important bearing on the relative economics of suspension and other types of bridges.

The chapter on multiple-span bridges is undoubtedly the most complete yet appearing in engineering literature.

A complete chronological table of suspension bridges, with main spans of 800 ft. and less, built since 1900, is included, as is also a bibliography of 70 books and papers.

REVIEW OF CURRENT HIGHWAY RESULTS AND FUTURE POLICIES

By THOS. H. MacDONALD

Chief, U. S. Bureau of Public Roads, Washington, D. C.

EACH succeeding annual meeting of this association presents the opportunity to review current highway policies and progress for the purpose of determining necessary future adjustments and modifications to meet more adequate the ever-changing conditions. This year perhaps to a greater degree than ever before there is need to focus the attention of the association upon the same objectives, to agree upon the most forward looking policies, and to throw the weight of this truly national organization even more powerfully into accelerating the rate of national recovery.

To a group wearied by the constant drive and tension of the past year, the idea of continued pressure cannot be welcome, but much less welcome is the alternative that other agencies far less qualified to carry the load effectively shall supplant the State and Federal highway organizations, until at least their whole strength has been exhausted.

In broad outline, the national aspects of the highway improvement and utilization field are impressive. Employment remains the great national problem. Highway work offers direct job relief and requires industrial production. Closely following the need for employment relief, and transcending State lines, is the whole field of greater traffic safety, and this involves many different types of facilities designed and provided with the requirement of safe use as the guilding motive.

As a fundamental in the extension of safe traffic facilities there is a need for a national program of railroad grade crossing elimination. The whole theory upon which most State laws are based, of placing a large percentage of the cost upon the railroads, must be discarded. There is no use arguing the equities involved. Highway officials are realists and will accept the fact that under existing conditions there is no other course. If we are to have adequate progress in this undertaking the highway funds will have to bear the major burden of the cost.

Proper coordination of transportation involves highway facilities to take the place of unprofitable branch line railroads as well as feeders to rail points, connections to airports, and probably the entrance of the highway organizations into the construction and maintenance of airports and emergency landing fields.

Out of adversity should come a finer environment through a permanent national policy of roadside planting, and the more extensive provision of recreational areas.

These are not predictions of some ideal or long-time future possibilities, but the real living issues that are before us now, and that must be attacked with renewed energy and faith based upon the remarkable progress that is being made under our present programs. Further, every idea here expressed is a highly potential contribution to employment, as shown by a review of the past year's work.

The Year's Contribution to Employment—Stimulated by the Public Works appropriations, State and Federal road building employment rose during the past year to a higher level than it had attained in any previous year. In the 12 months following passage of the act, direct employment on all Federal and State work amounted to 4,441,300 man-months, of which 2,120,800 was furnished by the various kinds of Federal projects and 1,813,500 was supplied by State maintenance work.

Equivalent to an average year-round employment of 370,000 men, this work of the year on State and Federal road construction and maintenance represents only the direct labor employed. Indirect employment generated may be conservatively estimated as approximately 1.4 times the direct, and total employment as not less than the equivalent of 880,000 men throughout the year.

It must be recognized, of course, that these figures are average. Actual employment varied from week to week and month to month, and the individuals employed changed from day to day. If account were taken of all the individuals participating the number would probably run to a million and a quarter.

Appreciation of the efforts made is carried in the report of the Executive Secretary of the Executive Council to the President under date of August 25 in the following words: "In the Federal classification, public roads have been outstanding in speed, accounting for half of the Federal expenditures but only a third of the Federal allotment."

Not only was the employment large in amount; it was also widely distributed throughout the nation, in the cities and in the country, in close approximation to the need. The rules and regulations required at least one project in not less than 75 per cent of the counties of each State; and the States met and exceeded the requirement. In at least eleven States every county has had one or more projects, and on the average the counties benefited directly make up 86 per cent of the total.

In the months since July there has been a continuous drop in the total of State and Federal employment. From a peak of 549,000 man-months in July there was a steady decline to 498,000 in September, with evidence available of a further decline in October. On the Public Works highway projects the drop was even more abrupt—from 336,400 in the peak month of June to 247,900 in September. All of the loss has been on the projects under State control. The small exclusively Federal program has been continued without reduction.

Last December estimates were submitted by the Bureau showing that there would be continuously rising employment until July, but beginning the first of September there would be a rapid increase. This prediction was substantially carried into effect. On the State-Federal work employment at the peak actually exceeded the predicted maximum by about 23,000 men, but this advanced the date at which the marked decline in employment became evident. Initiation of projects since the new money became available has not proceeded at the desirable rate, being somewhat under the rate attained last year during the same period. We estimate, however, that 60 per cent

of the new appropriation will be under contract by the first of the year.

If the present good repute of highway construction as an employment measure is to be preserved undamaged, the decline in jobs furnished must be halted by the provision of new work which will hold the level of winter employment at least as high as it was last year. The need this year will be fully as great as a year ago, and the response of the Federal and State road building agencies should be no less effective.

Forty-Hour Week for Road Work—Experience is now conclusive that some of the legal provisions of the emergency legislation ought to be changed. What may be characterized as out-of-door construction is subject to various delays and vicissitudes not inherent in industrial employment performed under cover and in permanent plants. The theoretical 30-hour week for out-of-door construction work approximates on the average an actual 24-hour week, and is further subject to seasonal shutdowns in a majority of the States. On the basis of the actual hours per week the rate of labor must be raised out of proper ratio to both agricultural and industrial rates to produce even a minimum living return. The only reasonable solution lies in raising the hours to at least forty per week and putting all road work—construction and maintenance—on the same basis. This will permit fairer distribution of the jobs available to individuals and make up through State employment the loss on Federal financed projects. The States owe this cooperation in this national effort to give employment to more individuals.

New Roadways Provided—As an emergency employment measure road construction not only has the advantages of prompt response and wide diffusion, but also the very great merit of producing permanent and needed additions to the nation's capital plant that carry no threat of present overproduction of consumption goods and supply transportation facilities that will be the imperative necessity of the future economic order.

The first Public Works highway project was begun in Utah on August 5, 1933. On October 27, not 15 months later, 16,330 miles of new roadway projects had been completed, 7,880 miles additional were under construction, and 2,845 miles more were definitely scheduled for construction—a total of 27,055 miles. Of the 16,330 miles completed, 9,157 miles are on the rural sections of the Federal aid highway system; 1,318 miles are on cross-city connections of the Federal aid system, and 5,855 miles are secondary and feeder roads outside of the Federal aid system. These were all useful improvements, and they remain—now that the work is done and the money spent—to yield further benefits, direct and indirect, in addition to those they have already afforded in the employment of otherwise idle men.

The character of the improvements covers the entire range of surface types, a condition which results from the adjustment of the type of improvement to the requirements of traffic and other factors considered in the case of each individual project. Now and then the criticism is made that Federal aid projects are of unnecessarily high type. The complete answer has always been found in the wide variety of types of roadways built with Federal assistance, and the reasonable relation of such types to traffic requirements. This condition, which has characterized the Federal aid work in the past, is particularly noticeable in the classification of surface types included in the Public Works program.

Types of Improvements Classified—The improvements planned on 25,479 miles of highways and streets in projects approved to September 30 are classified by types as follows:

Type—1st Stage	Miles	Per Cent
Graded, preliminary to surfacing	5,609	22
Low type, sand clay, gravel, macadam, low-cost bituminous mixes	14,022	55.1
High-type, bituminous macadam, portland cement concrete, brick	5,847	22.9
Total	25,479	100.

The variation of these percentages in these three groups of types testifies convincingly to the reasonableness of the adjustment of the improvements to traffic needs. In the case of the projects for improvement of Federal aid routes through cities and towns, 68.5 per cent of the mileage has been planned to have high-type surfacing, 24.2 per cent low-type surfacing, and 7.3 per cent is being graded preparatory to later surfacing. In striking contrast are the improvements on secondary roads. Only 11.6 per cent of these involve the construction of high-type pavements, and 64.2 per cent contemplate low-type surface construction, the remaining 24.2 per cent representing grading preliminary to surfacing. And, finally, the improvements planned for rural sections of the Federal aid system are of generally lower type than the municipal projects and of generally higher type than the secondary road projects; high-type pavements being 52.7 per cent of the total, low-type surfaces 24.7 per cent, and the grading projects 22.6 per cent.

In addition, the program as approved to September 30 includes 4,402 bridge construction projects of an estimated total cost of nearly $60,000,000, and—of special interest—482 grade-crossing-elimination structures involving an estimated expenditure of $22,500,000. Of the total of 482 structures, 439 separate the grades of railroads and highways, 43 those of intersecting highways.

Need for Grade Crossing Elimination Increases—The building of these grade-separating structures is a gratifying response to suggestions in the Federal Act, which listed these and other safety producing projects among the important objects of the appropriation. The importance of railroad grade crossing elimination is now heightened by the apparent imminence of developments in rail operation introducing the use of lighter, streamlined, high-speed equipment, with consequent increased hazard to rail as well as highway vehicles in case of collision. For this reason as well as the increased speed, volume and general importance of traffic on the main highways, the planning and carrying out of an accelerated program of grade crossing elimination must receive increasing attention in the future.

State laws governing the financial responsibility of the railroads for cost participation in grade crossing elimination are in general a heritage of the past. As a rough approximation, the railroads' share as fixed by, or under, these laws may be placed at 50 per cent. These laws now are an effective stop order on such improvements. While it is not invariably true, the margin is so narrow that practically it may be said that unless financing is supplied in major part by the public, there will be no adequate advance in these major traffic facilities for as long as we can now see into the future. This winter the laws in most of the States should be revised to make wholly flexible and more liberal public financing possible and relieve the railroads from any fixed percentages of cost contribution.

Footpaths and Roadside Improvements—Among other safety provisions specially listed as desirable objects of expenditure in the National Industry Recovery Act is the construction of footpaths. There can be no question

of the great hazard involved when pedestrians are forced to use the vehicular roadways of crowded highways in the environs of cities; nor can it be denied that such a condition exists at the approaches to practically all cities. In view of these facts, the emphasis placed upon the provision of footpaths by the act itself, and the rules and regulations, is fully justified. The response has been far too meager, necessitating the adoption of a policy by the Bureau of insisting upon the inclusion of footpaths and sidewalks in future projects where justified. No bridge in or near a city or town should be designed without sidewalks. Yet there have lately been submitted several such designs.

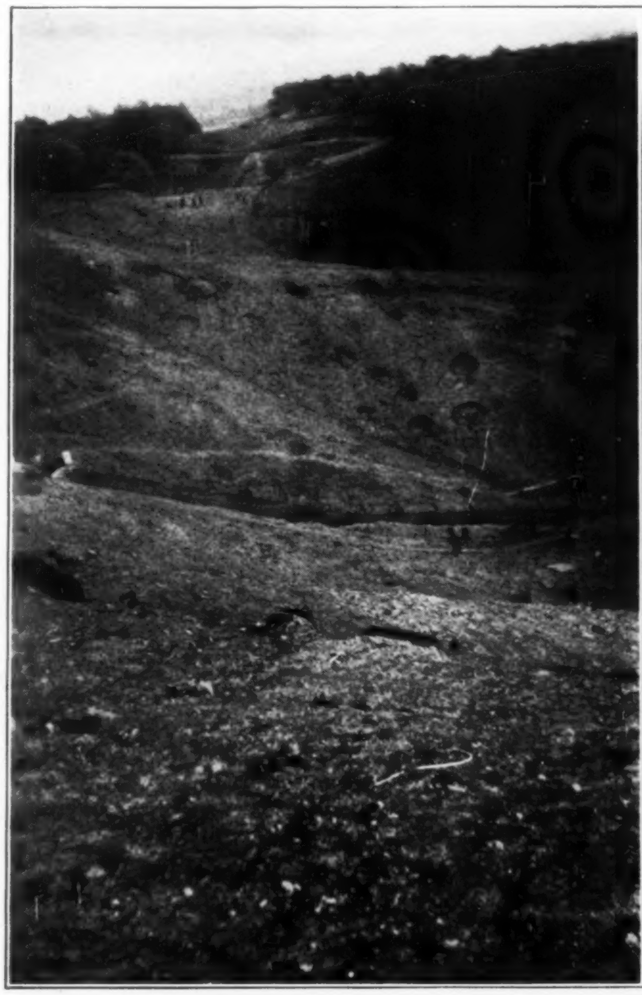
In the new departure of required roadside improvements a fairly satisfactory start has been made. It was necessary to put a minimum limit upon allotments for that purpose; and the indications are that the funds devoted to it will be little greater than the required minimum. Up to September 30 the special roadside improvement projects approved covered approximately 1,600 miles, but this does not include work planned and executed as a detail of road construction on projects not specified as roadside improvement undertakings.

Measured in dollars and miles, the venture into the landscape field can hardly be characterized as other than conservative. It is not, however, the cost of the undertakings that carries conviction of worth-while future progress, but the generally effective provision that has been made for work of this character by many of the highway departments and the evidence of thoughtful consideration that we find in the majority of the plans submitted.

The work of highway improvement cannot be regarded as finished until the natural beauty marred in the process of construction has been fully restored and reasonably enhanced. While the work is well begun, there is much to be learned that only experience can teach; there are organizations to be perfected and methods to be tried; and for these reasons a present program somewhat smaller than the more enthusiastic would desire is perhaps the part of wisdom.

Planning Future Programs—For nearly two decades the concentration of effort toward the improvement of the limited network of main roads represented by the Federal aid and State systems has been the central pillar of our highway policy. This policy has been based upon the principle of "the greatest service to the greatest number," and to the sustaining of this fundamental tenet every sound-thinking lawmaker, highway executive and engineer has given his wholehearted and unselfish effort. Occasionally there are attacks upon this policy, usually traceable to some specific self-interest which seeks a

Heavy Grading on an Indiana Highway Job



Portion of Cleared Right-of-Way on Route 50 Near Bedford, Ind., Showing the Rough Country Encountered in Building the Highway

A Fifty-Foot Cut and Forty-Foot Fill Being Started on Rough Grading on Route 50 Near Bedford, Ind.

benefit, which would in the end prove temporary, by departing from this plan of improvement of traffic routes in the priority fixed by their potential relative service.

It is not necessary to defend Federal aid and State highway policies. Every traffic survey which has been made has supplied concrete data pointing to the general soundness of these policies. It is desirable to bring before the public new data as they become available. In all preceding State and regional transport studies, it has been found that the Federal aid system is, as a system, carrying the greatest traffic density. In every case the general correctness of the selection of other roads included in the State systems has been demonstrated.

What an Indiana Traffic Survey Shows—The latest of the surveys—that conducted by the State Highway Commission of Indiana, and recently reported—provides most impressive confirmation of the established policies. Separating all roads of the State into four categories, the report shows that:

1. The primary section of the Federal aid system, comprising 1,830 miles or 2.4 per cent of the State's total rural highway mileage carries 30.4 per cent of the total vehicle-mileage.

2. The secondary section of the Federal aid system, comprising 3,093 miles or 4 per cent of the total rural mileage, carries 22.2 per cent of the total vehicle-mileage.

3. Together the two parts of the Federal aid system, comprising 4,923 miles or 6.4 per cent of the total rural mileage, carry 52.6 per cent of the total vehicle-mileage.

4. Other State highways not included in the Federal aid system, comprising 3,500 miles or 4.5 per cent of the total rural mileage, carry 13.8 per cent of the total vehicle-mileage; and

5. All other roads, aggregating 68,822 miles or 89 per cent of the State's total mileage, carry only 33.6 per cent of the total vehicle-mileage.

Clearly, by this report as by all its predecessors, the Federal aid and State highways are shown to be pre-eminently the roads of greatest service and rightfully first in order of improvement priority.

But there is much more than this to be gleaned from this interesting report by one who has some knowledge of other facts concerning the Indiana roads.

For example, we find that the 1,830 miles in the primary Federal aid system, which are only 2.4 per cent of all rural roads and serve 30.4 per cent of all rural traffic, are improved to the extent of 1,635 miles or 89 per cent with high-type surfaces. As they serve daily an average traffic of 1,721 vehicles, their right to high-type improvement will hardly be questioned; and it is most interesting to learn that whereas their average annual cost of maintenance is but $286 per mile, they earn a return in taxes paid by the traffic using them of $2,410 per mile per year.

The secondary Federal aid system, forming 4 per cent of the total road mileage and serving 22 per cent of the traffic, is less highly improved than the primary section. Only 1,587 miles of its total of 3,093 had high-type surfaces at the time of the survey, or just 51.3 per cent; which would appear to be rather consistent with the fact that the average traffic on this part of the system was only 745 vehicles per day. With lesser traffic density its tax earnings were naturally less than those of the primary section of the system, but still they amounted to $1,040 per mile per year, an amount comfortably greater than the average maintenance cost of $486 per mile per year.

Considering the two sections of the Federal aid system together, the average traffic density was 1,108 vehicles per day, the average tax earnings $1,550 per mile per year, and the average maintenance cost $413 per mile per year. By all tests it will be agreed that these roads "show cause" for their improvement, and one would be inclined to believe that a larger use of high-type surfaces on the secondary system, which would have the effect of reducing the maintenance cost, would improve the showing.

Turning now to the remaining sections of the State highway system—those sections that are not included in the Federal aid system—we find that these roads are predominantly improved with low types of surface. Only 18.7 per cent of this mileage is of high surface type. Clearly there has been no tendency toward extravagance in their improvement, unless it may be regarded as extravagant to continue in service surfaces which, under the average traffic of 410 vehicles a day that uses them, cost an average of $708 yearly to maintain. This does not imply criticism of the State highway administration. They are dealing in this group with roads of marginal economic utility, under the test of traffic return, which is only $575 per mile per year, and every indication of the record shows that they realize it and are proceeding accordingly. Yet they are in the State system, and apparently by every test of common sense, generally eligible on grounds of relative importance to be so included.

The great group of generally lesser roads that constitute 89 per cent of the total mileage and serve less than 34 per cent of the total traffic, have an average traffic of only 51 vehicles per day and earn in taxes paid by their traffic only $70 per year to offset an average annual maintenance expense of $187. The fact that only 2.3 per cent of this mileage—1,575 of a total of 68,822 miles—is improved with high-type surfaces, would indicate that there has been no serious overdevelopment of these roads; and the question that remains for future determination is whether, to what extent, and precisely where future improvement will produce the greatest return.

The example made possible by the very excellent Indiana study is typical of conditions existing in the great majority of our States; and it affords a complete answer to selfish or uninformed criticism of highway policies.

The course we have been following has been fairly clear. The choice of the most important roads has been rather obvious. What we have been doing is what the President calls "doing first things first." That we have done it rather well the generally appreciated usefulness of the Federal aid and State highway systems testifies without the factual aid of the many traffic surveys.

Improvement of Secondary Roads—We now approach more difficult decisions. As each additional mile of highway is improved, the choice of succeeding mileage for improvement becomes progressively a matter of narrower and narrower margins. And the future extensions of improvement will be in a class of roads on which there can be expected no such growth of traffic following the improvement as we have experienced on the roads with which we have hitherto been dealing. All the facts at our disposal indicate that the further extensions of improvement must enter the class of land-service roads, as distinguished from the general-use highways with which, as State and Federal officials, we have been primarily concerned in the past. And, since no amount of improvement will convert a typical land-service road into a road of general use, the only traffic increase to be expected is that which may result from the development of a denser population or more active industry on the land immediately served. No great waves of new traffic will

come flooding to these roads, such as we have in the past experienced on the main roads. So there will generally be no counting upon future traffic growth to justify any serious mistakes of overdevelopment that may now be made.

These things are emphasized not to discourage the further extension of improved mileage, but simply to stress the high importance of informed and intelligent planning of the work to be done. We must continue the work we have begun in the secondary and feeder road field. It will be justified not entirely on grounds of direct service furnished to the immediate users of the roads, but on grounds of general social and economic necessity, and it will have to be tied in closely with general social and economic trends, some of which are even now forming.

The task involved is one for which there are no agencies, other than those represented in this association, that are fitted. It is one that should be accepted with the determination to carry it through from the beginning in strict accordance with economic and social principles.

As a first step it seems to me there is need in every State of a traffic survey directed to the discovery of the roads additional to those already constructed, improvement of which may be justified on reasonable grounds of economy or social usefulness. If authority to undertake such studies does not at present reside in any of the State highway departments, such authority should be sought at the coming legislative sessions.

For such planning purposes, as you know, the last Federal Act makes available up to 1½ per cent of the funds apportioned to the States; and there is no better use to which such sums can be put in the present stage of highway development.

At recent sessions of the State legislatures there was a decided tendency toward the enactment of laws transferring to the control of the State highway departments all or large parts of the mileage of roads remaining under the authority of local officials. Under the pressure of a temporary necessity to find ways of relieving heavily taxed property holders, there is a tendency to couple with the administrative transfer a shifting of the entire burden of financing the local road work to the shoulders of the users of roads, whose tax payments are at the same time diverted in part from road uses to others having no relation to the highways.

Of the advantages of the administrative change there can be little question; but in the taxing provisions that may at this time be attached to it, there are, to my view, grave possibilities of injury to the future of the highways. No student of highway economics can fail to recognize that the principal benefit of the great bulk of local road mileage is to the land to which it gives access. No one with knowledge of the small amount of travel on most of these roads can believe that their improvement can be supported by taxes on road users exclusively; and the attempt to do so, in the long run, lead to only one of two results or a combination of both; either the killing of the hope for a desirable measure of local road improvement or the depreciation of the investment already made in the main roads.

Traffic Surveys Desirable for Guidance of Legislators—By and large, the action of our legislatures is consistent with what is understood to be in the public interest. In respect to the highway program of the future they will respond properly to facts presented for their guidance. The trouble is that they are beset on all sides by selfish and misguided counsel, and there is on the side of truth and real wisdom a lack of effective advocacy and marshaling of facts.

It is for the purpose of supplying such facts that the making of traffic surveys of the type suggested is indispensable. The counsel of the State highway departments in their respective States ought to be directed toward the deferring of far-reaching legislative action with respect to local road administration and finance until the essential facts can be thus obtained.

Stress is placed upon this matter of secondary or local road improvement because it is of critical importance in the shaping of future highway policies, and because its new problems demand very serious study.

There is, however, another matter of equal importance, that may perhaps be presented in fewer words. This is the urgently needed improvement of main routes in and near cities, and the refinement of other heavily traveled highways needed for the promotion of safety.

Modernization of Municipal Highways—When, a few short years ago, we began the systematic improvement of the main rural roads, the portions of our whole street and highway network that were most adequately improved were the city streets and the adjoining rural highways. We have now progressed in the rural road work to the point where it may be said that a reasonably satisfactory condition exists on the long rural stretches of most of the State highways. Meanwhile, however, traffic has grown, in and near the cities, to such proportions that the once relatively adequate facilities there provided have become generally the least efficient sections of the entire system. On the rural roads improved in the earlier years, when the speed and density of traffic permitted lower standards of road design than can be justified today, there are also curves and other features that must be revised to adapt the improvements to modern requirements. As their early improvement would suggest, many of these roads are today the most heavily traveled of the rural thoroughfares.

The expeditious modernization of these municipal and main highway facilities with the reasonable extension of secondary road improvements are the two most useful employments to which we can devote our energies and our resources in the years immediately ahead.

Unlike the secondary road improvements there can be no question, in regard to these other needs, as to either their direct benefit to the traffic or the ability of the traffic to pay the cost. Also, unlike the secondary road improvements, the problems they present are not dissimilar to those that have long been the every-day concern of many, if not most, of the State highway departments. In respect to this class of improvements, the safety of human life is as strong an impelling factor as economy of service in the narrow sense, and they center in large part in the financially hard-pressed municipalities. In many cases they must be indefinitely postponed unless revenues other than those previously available are devoted to them.

There are many other points which might be dwelt upon as necessary to our advancing technique of highway administration and engineering, such as traffic control, the application of sound methods of soil stabilization for subgrades, and more accurate principles of road design, but these would unduly prolong an already too lengthy discussion. If our vision can be constantly raised to higher degrees of proficiency and earnestness, there are as yet unreached possibilities for public service for the combined State and Federal highway organizations. It is our obligation as well as our opportunity, out of national adversity to secure finer and more permanent highway facilities as our contribution to national progress.

The foregoing is a paper presented November 12 at the 20th annual convention of the American Association of State Highway Officials at Santa Fe, N. Mex.

The Washed Sand Is Being Taken Out of the Container—Washed Out, to Be Exact. The Washed Coarse Aggregate in Its Container Lies in Front of the Washing Machine.

PHYSICAL RESEARCH BY THE BUREAU OF PUBLIC ROADS

An Outline of Current Investigations

CURRENT activities of the U. S. Bureau of Public Roads in investigating materials, conditions, and methods are explained briefly in the report of the Chief of the Bureau rendered September 1, 1934. Some of the work described is a continuation of earlier experiments, some is entirely new, some is being carried on independently by the Bureau and some in conjunction with other agencies. Following are excerpts and quotations:

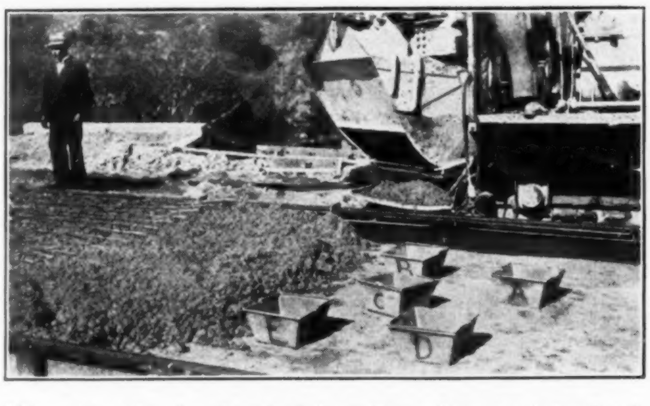
Motor-Vehicle Impact Investigations.—The current research in this field is the study of the effect on pavement surfaces of the suddenly applied forces developed by motor-vehicle impact as compared with the effect of static or slowly applied forces of the same magnitude. Preparations have been made for laboratory tests under carefully controlled conditions of temperature and moisture. These tests will be made upon massive specimens of concrete mounted as cantilevers utilizing a specially designed pendulum-type impact machine to produce the impact. This machine, now practically completed, consists of a structural frame carrying a vertical pendulum 100 in. in length with a motor-truck wheel mounted at its center of percussion. The pendulum is to be swung against the vertical face of the test specimens and the strains and deflections of the specimens under the resulting impact reaction will be measured and compared with those caused by an equivalent static force.

Twenty-six specimens have been fabricated and are ready for test. Essential preliminary calculations and calibration tests have been made.

Subsurface Explorations.—This new investigation has for its object the development of instruments and operating technic which will reveal subsurface formations of rock or other materials of concern in the construction of highways and highway structures.

At the outset of the work in September 1933, two independent scientific methods for sounding relatively shallow rock depths were considered as being probably most suitable. Both of the methods have been used ex-

When a Large Amount of Work Is to Be Done at One Place the Fixed Equipment Is Set Up in a Fixed Laboratory. Reading from Left to Right, This Equipment Is (1) A Washing Machine, (2) The Mechanical Tamping Machine for Jigging or Vibrating Test Specimens, (3) The Motor and Line Shaft, and (4) A Special Mixer for Making Comparative Concrete for Test.



Where Samples Are Required from Several Parts of the Batch, Containers Are Placed on the Subgrade and the Samples Taken as the Batch Is Spread by the Bucket. This Insures Fair Samples from Obviously Different Parts of the Batch.

tensively in mining and, to some extent, for shallower work. One involves the measurement of the electrical resistivity of the soil while the other, known as the seismic method, depends on the propagation and measurement of sound waves through the earth. As the first method mentioned is the simpler it was given first attention and a convenient and practical field apparatus has been designed, built, and given a considerable amount of use locally. Results to date justify the belief that this method of test can be used to advantage for determining the amount of rock excavation in highway construction, for locating dredging and quarry material, and for determining rock depths for bridges or other structures.

For the seismic tests a three-element oscillograph has been designed and is now under construction. It is believed that this method will be particularly useful in connection with bridge construction.

Highway-Bridge Investigations.—Tests to determine the friction developed in the sliding of expansion bearings in highway bridges, were described in the reports of the last 2 years. The originally scheduled tests in this investigation have been completed and a few additional tests involving other combinations of metals are now being made. The data which have been obtained are being analyzed and a detailed report is being prepared.

Measurement of Road-Surface Roughness.—The development of a standardized vehicle for use with the relative roughness indicator as described in last year's report has been continued. Because of certain difficulties encountered in the spring action of the single-wheel trailer, the development has been directed toward a means for satisfactorily damping the spring motion and considerable progress has already been made in this effort.

Concrete Pavement Design.—Studies of the structural action of concrete-pavement slab and joint designs have been conducted actively throughout the year and the original program of tests is now practically complete. The scheduled tests to develop the efficiency of joint designs and of the relative balance of cross-sectional designs have been completed.

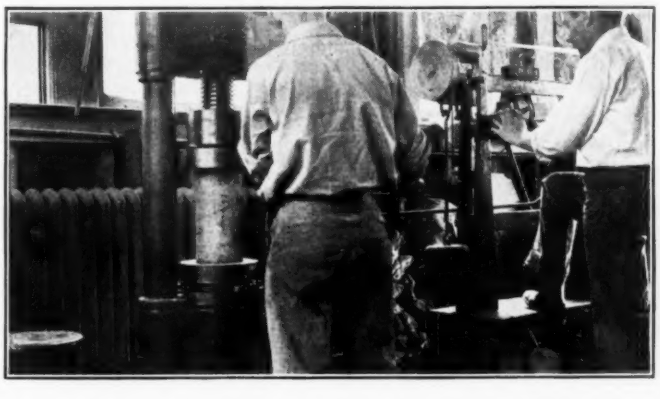
Advantage was taken of the unusual temperature conditions of the past winter to obtain data concerning the effects of subgrade freezing on the load resistance of pavement slabs. Valuable data on the magnitude and distribution of stresses due to restrained warping have also been obtained. Two of the five scheduled reports on this project are in practically final form and the others are in the course of preparation.

Portland Cement—Effects of Freezing and Thawing.—During the year work was started on two laboratory investigations designed to develop information regarding the effect of variations in the chemical composition of portland cement on the durability of concrete. In one series a number of specially prepared cements differing widely in composition are being subjected to an accelerated weathering test in combination with sands of both good and poor quality. In the other series, which is being conducted simultaneously in eight research laboratories under the sponsorship of the Highway Research Board, 11 brands of commercial portland cements differing in composition are being subjected to alternate freezing and thawing. This problem is of importance in connection with concrete for pavements and bridges, since in certain sections of the country structures are subjected to severe weathering and there is good evidence that the quality of the cement may affect the resistance of the concrete to weathering to a considerable extent.

Aggregates—Rattler and Soundness Tests.—Several investigations dealing with the methods of testing and the physical properties of stone, gravel, sand, etc., are being continued. These tests are being conducted, for the most part, in cooperation with various standardizing bodies, such as the American Association of State Highway Officials and the Highway Research Board. Additional information regarding the possibilities of the Los Angeles rattler test, referred to in the report of last year, was obtained and a report prepared for the use of the committee on materials of the American Association of State Highway Officials. Additional data were obtained in the development of improved laboratory methods of testing the soundness of aggregates. This work, conducted in cooperation with the American Association of State Highway Officials, contributed toward the adoption of two new tentative association standards covering methods of conducting soundness tests of aggregates.

Vibration in Finishing Concrete.—The promising results indicated by the series of tests to determine the effect of finishing pavement concrete by vibration led to a decision to continue this investigation during the coming year. In this work the latest types of vibrating equipment are being studied. As a result of the work done already along this line, a marked interest has been developed in this method of finishing which, from present indications, may eventually displace the methods now in use.

The Curing Methods.—The study of methods for curing concrete has been temporarily delayed owing to the pressure of other work. However, the necessary equipment has been constructed and the tests will be conducted during the coming year. Tests of light-weight aggre-



Test Cylinders Are Broken in State Laboratories Which Have Cordially Co-operated with the Bureau in All of Its Field Research Work

gates have been completed and a report is now being prepared for publication. Further tests were also made in connection with the standardization of the flexure tests used in the control of paving concrete. Certain variables which may affect the results were investigated.

Protective Surface Treatments for Concrete.—Recent inspections of concrete specimens stored in Medicine Lake, S. Dak., to determine the effect of various surface treatments in protecting the concrete against alkali attack indicate that, insofar as specimens treated with water-gas and coal-gas tar are concerned, resistance to attack is increased by (1) lowering the water-cement ratio, (2) increasing the length of the moist-curing period, (3) treating the concrete after as short a drying period as possible subsequent to moist curing, and (4) by the use of a coal-tar seal coat following initial priming with water-gas tar.

Joint Fillers.—A recent development in preformed joint fillers for concrete structures, particularly pavements, has been the introduction of the so-called "resilient type" to replace the conventional plastic fillers which have been in use for many years. The results of a laboratory investigation designed to compare the efficiency of various types of resilient fillers, such as cork, sponge rubber, fiber, etc., were published during the year. The major conclusions from this investigation are as follows:

Considering the essential features of the resilient types of filler, as determined by the tests described in the report, the different types studied may be rated as follows: Sponge rubber and cork, fiber, and asphalt-rubber.

The different samples of sponge-rubber filler exhibit a considerable range in physical characteristics, which warrants careful investigation of any particular material prior to use.

A compression test with three edges restrained is believed suitable for testing resilient expansion-joint fillers. Measurements of the recovery, extrusion, and applied load can be made in a single test.

Concrete Mixtures.—Studies of concrete mixtures have developed indications of certain relations not heretofore established between the proportions of the solid ingredients of the concrete, the water content, and the strength and density of the resulting concrete. These relations may be stated briefly as follows:

For a particular combination of sand and cement a relation exists between the amount of coarse aggregate and (1) the total voids in the concrete mixture and (2) the amount of water required for basic or any relative proportion of basic water contents:[1]

Likewise, for a particular coarse aggregate content, a relation exists between the ratio of the amounts of sand and cement in the mixture and (1) the amounts of water required as the basic and various relative water contents, and (2) the corresponding total voids in the mixture. As the sand-cement ratio is uniformly increased, a uniform change occurs in the amount of water required for the basic and each relative water content and the total voids in the concrete corresponding to each. In these tests, increase in the ratio of sand to cement resulted in an increase in both the amounts of water required for each relative water content and the corresponding total voids in the concrete.

For each relative water content, using the same kinds of materials, the slump of every concrete mixture will be the same, regardless of the proportion of cement and aggregate used in it.

[1]Basic water content is that amount of water which produces maximum density in a particular combination of materials. Quantities of water expressed in terms of basic water content (as a ratio) are referred to as relative water contents.

Screens in This Machine Separate the Materials for Size as the Washing Is Done

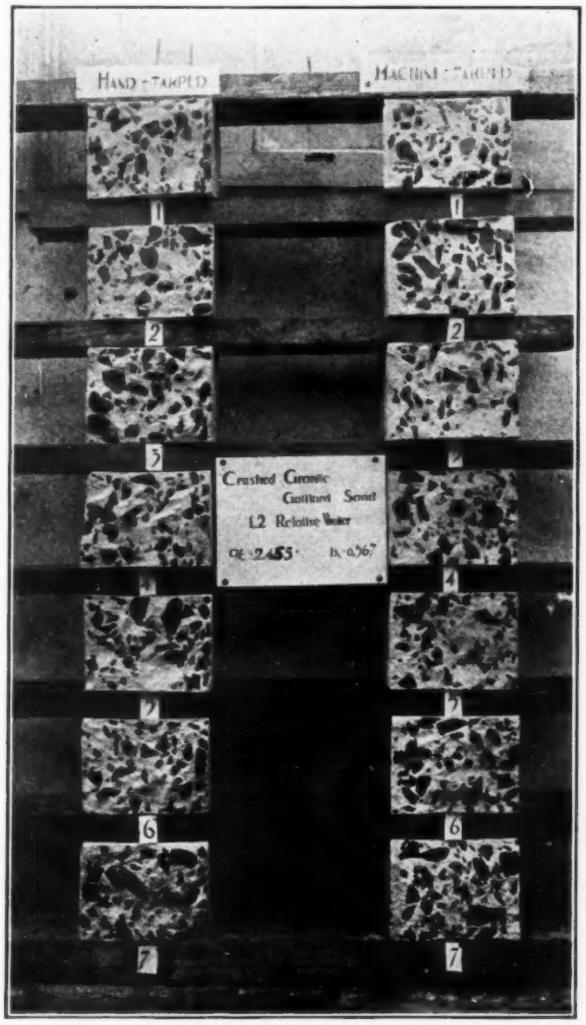
Bituminous Materials and Bituminous Paving Mixtures.—Several years ago the Bureau conducted an investigation of sheet-asphalt and asphaltic-concrete paving mixtures on a circular track or roadway at the Arlington Experiment Farm. The foundation for the experimental sections of bituminous pavement was a reinforced concrete base 13 ft. wide and 180 ft. in mean diameter. Two series of tests were made and involved a total of 60 test sections which were subjected to a traffic of heavy trucks. The test sections in the first series were subjected to 50,000 truck trips and the second series to 64,000. The observed performance under this traffic, as affected by the variables included in the various sections, furnished the data for a report which has been published during the past year.

Low-Cost Bituminous Surfaces.—Two of the experiment projects, built in cooperation with State highway departments for the study of low-cost bituminous-treated surfaces, are active at the present time. One of these is in South Carolina and the other in Nebraska. The project in South Carolina is for the study of bituminous surfacing of several types on bases of marl and sand-clay. In Nebraska the experiments are with mixed-in-place construction in the sand-hill area of the state, the mineral aggregate being the soil material of the area which is largely blow sand. Periodic inspections are made of both projects and records of maintenance costs and service behavior are being kept.

Simplification of Standards and Tests.—Mention has been made in previous reports of the cooperative effort of the Bureau, the State highway departments, and the

asphalt industry to simplify the tests and standardize specifications for the liquid asphaltic materials which are used extensively in low-cost road construction. A review of the 1933 specifications of the State highway departments for materials of this character indicates substantial progress in obtaining acceptance of the provisional standard specifications which have been recommended. This work is being continued and another series of regional meetings will be held during the coming year for the further promotion of uniformity in the requirements of specifications.

Weathering Tests on Bituminous Mixtures.—The investigations of the weather-resisting properties of liquid asphaltic materials, undertaken 2 years ago, are being continued. In these studies the basic changes occurring in such materials, when exposed to atmospheric conditions, are determined and the results correlated with the results of various laboratory tests. The ultimate purpose is the development of methods of test which will insure the use of durable materials and thereby result in minimum maintenance costs. A report of the work done during the summer of 1932 has been published and the data obtained in 1933 are being assembled for publication. The investigation has been broadened to include a study of the weathering properties of bituminous mixtures subjected to atmospheric exposure and controlled traffic. For this purpose a small circular track, similar to the indoor track described in last year's report, has been constructed out of doors. This phase of the study includes asphaltic materials from different producing fields and refined by different manufacturing processes.



Samples, Hand Tamped and Machine Tamped (Jigged) Arranged to Facilitate an Optical Study of Density and Other Important Characteristics

A Good Deal of Field Work Has Been Done to Determine the Uniformity with Which Concrete Is Mixed. For this Work Weighed Samples of Concrete Are Washed in a "Washing Machine"

The studies of low-cost bituminous mixtures on the indoor circular track, described in last year's report, are being continued.

Design of Hot Mixtures.—The laboratory study of the factors essential to the proper design of hot bituminous paving mixtures is being continued. The work consists largely of making stability tests. A future phase of this investigation will be a correlation of the service behavior of bituminous pavements with the results of the stability tests.

Subgrade Investigations.—Subgrade investigations have formerly been directed toward the establishment of the fundamental relationships of the physical phenomena observed when soils are subjected to load and variable climatic conditions. During the past year the work has taken on a somewhat more practical aspect in that it has been directed mainly toward the preparation of available information in such form as to make it more readily usable by the highway engineer, and the development of apparatus and procedures for attacking particular problems of highway construction.

The routine procedures for testing subgrade soils, referred to in last year's report, have been recommended to the American Association of State Highway Officials and the American Society for Testing Materials for adoption as tentative standards and, if accepted, will become a uniform basis for the formulation of specifications throughout the country.

Reports on hydraulic-fill settlement and on frost heave in highways and its prevention, which show the value and application of subgrade information in practice, have been published. Continued investigation of the mechanical device for determining the liquid limit of soils has indicated its suitability for standardizing the liquid-limit

test in various laboratories, as well as for revealing information of a character not furnished by any other test. A procedure for determining the centrifuge-moisture equivalent, which will eliminate the relatively expensive centrifuge, is being investigated and appears promising at the present time.

A standard procedure for performing the flocculation test has been established. This test has proved particularly valuable in differentiating between the good and poor varieties of limerocks, caliches, etc.

Continued research on the hydrometer method of mechanical analysis of fine-grained materials has led to the publication of two reports, the first dealing with the accuracy of the method, and the second detailing a procedure for making the mechanical analysis of portland cement. In addition, progress has been made in the development of a method for rapid mechanical analysis suitable for control purposes in the field. This method will eliminate the use of sieves and scales to a large extent.

A report describing a procedure for selecting soil suitable for use in mud-jacking operations has been published and further investigations of this process may furnish additional information of practical value.

The combined compression and permeability apparatus as proposed by Charles Terzaghi, has proved valuable in the investigation of special problems relating to the behavior of soils under load and in the presence of water. Recent investigations of the expansive action of soils on absorbing water indicate a possible solution of the problem of warping of concrete pavements. These investigations will be continued on an enlarged scale.

A series of admixture tests has confirmed the statement previously made that certain simple tests were satisfactory for indicating the presence of the various soil constituents. A project has been inaugurated to determine the stability requirements of soils used in various parts of the highway structure and to investigate means of increasing the stability by admixture and manipulation. The apparatus used in these tests will include the drainage indicator and soil consolidator. The material tested will include the coarse as well as the fine fractions of soil. Since the purpose of the investigation is to furnish practical information regarding the construction of low-cost roads, base courses, earth fills, and the like, the results of the research will ultimately be carried to the field for demonstration.

Observations of the Virginia demonstration road have been continued and a progress report is in preparation.

Cooperation with the State highway departments in the making of subgrade surveys, in the design of subgrade treatments and road surfaces, and in the establishment of soil laboratories, has continued as in past years.

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Cost of Mud Jacking in California

The method of raising sunken concrete pavements by mud jacking has been employed by the Division of Highways of California since 1931 with satisfactory results. In the recently issued 9th biennial report (Nov. 1, 1934) of the Division of Highways, T. H. Dennis, Maintenance Engineer, gives the following on this work:

The concrete pavement throughout the state was carefully inspected and at all locations where this type of work was suitable the process of mud jacking was completed by January, 1933. The earthquake in the southern part of the state on March 10 of that year settled and warped considerable pavement. The outfit was then reassembled and all damaged slabs in the area jacked into place. Since the work was completed in the earthquake section, the outfit has been kept at work in the San Francisco Bay area.

Throughout the course of the work particular attention has been given to the quality of the muck used. It is desirable to use as stable a material as possible to reduce shrinkage and further settlement. This result is obtained by the selection of sandy loam of as coarse a grading as will produce a mixture which can be forced into place.

The mud jacking crew consists of a foreman, two equipment operators and three laborers, and the equipment consists of the following:

1 mud jack (mounted).
1 compressor on 1½-ton truck.
1 600-gal. water tank on 1½ ton truck.
1 dump truck (part time).
1 light express automobile.
1 jack hammer.
1 pavement breaker.
1 Hauck pavement burner.
Drills and small tools.

The cost and quantities of this work as performed from May 15, 1933, to June 15, 1934, are as follows:

Labor	$11,273.87
Equipment rental	8,239.60
Cement	1,603.75
Supplies	1,787.68
	$22,904.90

Material used:

Cement	3,014 sacks
Muck	2,784 cu. yds.
Water	165,050 gal.

Area of pavement raised 40,237 sq. yds.

The pavement raised varied from 7 in. x 20 ft. sections to 7-9 in. x 60 ft. and 9-11 in. x 30 ft. sections. The vertical distance raised varied from 0.6 in. to 4.4 in. with an average, based on the quantities given above, of 2½ in.

The average unit cost amounts to $0.588 per square yard. The cost of muck and cement in place and not including the water is practically $8 per cubic yard. At first glance this cost seems high for filling material but when it is considered that the riding quality of the pavement is greatly improved and the uniform appearance of the concrete surface preserved, it is considered that the method is well justified as compared to surface patching, even though the cost is slightly higher.

Repositioning Pavement Slabs.—The "mud jacking" outfit is satisfactory for raising cement concrete pavement vertically to place but the same equipment could not be used to correct horizontal displacement such as occurred on Route 60 near Huntington Beach as a result of the earthquake in March, 1933. Wide gaps appeared at the longitudinal joints of the pavement extending over a distance of ten miles at some fifteen different locations ranging from 140 to 400 ft. in length and from 2½ to 8 in. in width, and it seemed desirable to correct this condition by replacing the slabs to their original position rather than filling the opening.

District VII forces developed a hydraulic jack of rectangular design capable of exerting a pressure of 900 tons or more. The lower member of this jack consisted of two pieces of ⅝ x 8 in. steel, about 40 ft. long, with steel spreader blocks welded between them at each end. The upper member consisted of 8⅝ in. well casing with a hydraulic jack fitted at one end. The vertical members of the rectangle were 8 in. x 8 in. steel billets about 50 in. long and served as levers to transmit and build up the force applied by the jacks while the lower member held them in place. The short vertical members were so pivoted as to give a 2:1 leverage or a 4-in. stroke at the pavement and an 8-in. stroke at the jack.

STATE HIGHWAY CONSTRUCTION IN 1934 AND 1935

Reports from Highway Officials Showing Probable Expenditures

New Jersey

The following program for 1935 was prepared by the State Highway Commission and forwarded to the Governor for consideration in the matter of preparing the budget for next year. Of course, this program can only be considered as tentative pending whatever action the Legislature may take at such time as it may act on the appropriation for highway construction for 1935.

1935 PROGRAM RAILROAD CROSSING ELIMINATIONS LEGISLATED STATE HIGHWAY SYSTEM

Route No.		
3	N. Y. S. & W. R. R. (Erie)—Paterson	$ 95,000
S4B	Bergen County R. R. (Erie)—Fairlawn	100,000
S4B	N. Y. S. & W. R. R. (Erie)—Franklin Lakes	80,000
21	Erie (Greenwood Lake Br.)—Newark	80,000
25	P. R. R.—Dayton	100,000
25	P. R. R.—Kinkora	70,000
28	L. V. R. R.—Roselle Park	75,000
S31	Lehigh & New England R. R.—Augusta	60,000
S40	C. R. R. of N. J. (N. J. So. Br.)—Woodland Twp.	75,000
	Total	$735,000

PROGRAM FOR 1935 FOR PURCHASE OF RIGHT-OF-WAY (D-8) AND CONSTRUCTION OF STATE HIGHWAY SYSTEM (D-6)

Rt.	Sec.	Location	Mileage	Right-of-Way	Bridges, Viaducts and R. R. Grade Separations	Road Construction	Total Estimated Cost
1	9	Bayonne Section—Bit. Mac	1.2	......	......	$70,000	$70,000
4		Raritan River Bridge	1.0	......	$2,000,000	......	2,000,000
S4B	1 & 2	Arcola-Oakland	10.2	$275,000	......	......	275,000
6	7	Hasbrouck Heights—R. C. Pavement	5.5	870,000	790,000	660,000	2,320,000
6	8 & 9	Clifton	5.1	745,000	......	......	745,000
10	7	Livingston—R. C. Pavement	4.6	350,000	50,000	350,000	750,000
25		Dayton By-Pass—R. C. Pavement	5.7	165,000	40,000	380,000	585,000
25		Hightstown By-Pass—R. C. Pavement	4.5	......	150,000	285,000	435,000
25		Crystal Lake R. C. Pavement (wid.)	7.0	200,000	150,000	550,000	900,000
25		Burlington Road—R. C. Pavement (wid.)	4.0	55,000	10,000	255,000	320,000
28		Westfield Ave.—R. C. Pavement	2.0	......	5,000	160,000	165,000
28		Westfield Ave.—R. C. Pavement	.7	......	......	115,000	115,000
29A		Stockton-Frenchtown—R. C. Pavement	12.0	......	......	275,000	275,000
34		Shark River Sta	7.5	100,000	......	......	100,000
39		Trenton By-Pass (North)	8.0	300,000	......	......	300,000
S40	3 & 4	Route No. 40—R. C. Pavement	12.0	20,000	......	500,000	520,000
44		Penns Grove—R. C. Pavement	4.9	25,000	......	200,000	225,000
Misc.		Miscellaneous emergencies and utility rearrangements, etc.	...	......	100,000	332,397	432,397
		Totals	95.9	$3,105,000	$3,295,000	$4,132,397	$10,532,397

PROJECTS FOR SUBSTITUTION IN CONSTRUCTION PROGRAM FOR 1935 IN ACCORDANCE WITH CHAPTER NO. 193, P. L. 1933

Rt.	Sec.	Location	Mileage	Right-of-Way	Bridges, Viaducts and R. R. Grade Separations	Road Construction	Total Estimated Cost
1	9	Bayonne—Bit. Conc.	3.0	......	$125,000	$2,000,000	$ 2,125,000
3		Paterson Plank Road—R. C. Pavement	6.8	$800,000	430,000	700,000	1,930,000
S-3	2	Route No. 3—(R. of W. and Grad.)	2.2	175,000	......	275,000	450,000
4		Absecon	11.5	500,000	......	......	500,000
S4B	1	Arcola—R. C. Pavement	5.2	......	300,000	900,000	1,200,000
6	8 & 9	Clifton—R. C. Pavement	5.1	......	900,000	1,050,000	1,950,000
21	4B	Clay St.—Asphalt	.8	1,725,000	......	150,000	1,875,000
21	4C	Oriental St.—Asphalt	.8	400,000	1,150,000	......	1,550,000
S-31		Ross' Corner—R. C. Pavement	5.0	100,000	75,000	225,000	400,000
34		Shark River Sta.—R. C. Pavement	7.5	......	40,000	435,000	475,000
39		Trenton By-Pass—R. C. Pavement	8.0	......	350,000	830,000	1,180,000
41		Haddonfield Road—R. C. Pavement	7.0	......	240,000	385,000	625,000
44		Oldman's Creek	...	......	125,000	......	125,000
45 & 48		Woodstown By-Passes—R. C. Pavement	2.0	50,000	25,000	125,000	200,000
50		Corbin City—R. C. Pavement	.8	......	......	40,000	40,000
		Totals	65.7	$3,750,000	$3,760,000	$7,115,000	$14,625,000

The above R. R. program is also included in the general program and is not in addition thereto. Also, these R. R. projects are only those involving the elimination of existing R. R. grade crossings and this R. R. program does not show the R. R. grade separation projects on new alignment where existing crossings are not involved. Reconstruction of existing R. R. separation bridges would be included in the above program.

W. G. Sloan, Trenton, N. J., is State Highway Engineer.

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Connecticut

For the fiscal year 1935 the State Highway Department constructed and accepted a total of 283.09 miles of roads divided as follows:

State Aid	21.16
Town Aid	183.51
Trunk Line	14.91
P. W. S.	16.32
T. A.	4.00
N. R. H.	14.34
N. R. M.	10.83
P. W. A.	14.94
N. R. S.	3.08
	283.09

It will be noted 63.51 miles were constructed with the assistance of Federal Aid funds. The State Aid, Town Aid and Trunk Line construction was financed entirely from State funds.

The State operated in 121 towns under the Town Aid Appropriation. The first appropriation for Town Aid work was made by the Legislature in 1931 and the law provides that $3,000,000 each year shall be allocated from the receipts of the Motor Vehicle Department for this type of work. It will be interesting to note that a total of 183 miles were definitely constructed under state specifications and state inspection. The work in 121 towns additional involved an expenditure of over a million dollars and covered the less permanent work, that is, shaping, grading, oiling, surfacing in some cases, installing of drainage, structures and things of that character.

On December 15 there were 60 contracts involving an expenditure of $6,105,000 which, of course, will be carried over into the season of 1935.

At this time (Jan. 14) it is not possible to give information concerning the probable expenditure for 1935 aside from these items because the legislators are in session and appropriations will not be determined until late in the year.

Of the 20 projects planned under the original appropriation from Government N. R. A. in the amount of $2,865,000, 16 have been completed and the other 4 are between 75 and 98 per cent completed. All will be finished early in the spring.

In the second appropriation of $1,454,868, contracts to the amount of $818,446 have been awarded.

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Maryland

The total expenditures in 1934 were $13,800,000, of which $6,250,000 was for construction. A total of 155 miles of road was built. The 1935 program is not sufficiently definite at this time to give any detailed information.

H. D. Williar, Jr., Baltimore, Md., is Chief Engineer, State Roads Commission.

Alabama

EAST South Central States—Alabama . . . .

The following statement covers the fiscal year Oct. 1, 1933, to Sept. 30, 1934:

U. S. Public Works and Emergency Federal Aid Completed:

	Miles
Graded and drained	45
Bituminous types	74
Cement concrete	126
Total	245

6482 lin. ft. of bridges were completed during this period.

The above work involved an expenditure of $3,669,900.

State and U. S. Public Works Projects Under Construction Oct. 1:

	Miles
Graded and drained	156
Sand-clay and top-soil	19
Gravel and chert	72
Bituminous types	340
Cement concrete	44
Total	631

10,534 lin. ft. of bridges were under construction on this date.

The above work involves a contract total of $9,822,230.

The program for 1935 at present is based on Federal funds. The following is a tentative layout of this program:

	Miles
Graded and drained	70
Gravel and chert	29
Cement concrete	57
Bituminous types	97
Total	253

The amount set up for the above construction is $4,259,000.

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New Mexico

The following is a summary of NRH, NRM and State Construction completed in 1934:

Type	Carried Over from 1933 Miles	Est. Cost Is for Portion Completed in 1934	Total Est. Cost of Proj.	Started and Completed in 1934 Mileage	Started and Completed in 1934 Est. Cost
Grade and drain	9,790	$ 37,710	$ 94,274	11,739	$ 115,000
Gd. dr. and base	35,154	479,548	817,234	37,425	277,562
Gd. dr. and concrete	2.106	247,243	257,440	3.161	258,147
Gd. dr. and oil	1.933	58,832	67,832	59.379	621,510
Gd. dr. and rock asphalt	....	.....	.....	2.380	252,169
Oiling only	79.063	187,615	422,107	205.161	697,565
Reconstruct'n and rock A.	27.077	344,831	432,765	....	.....
Rock A—widening	0.500	8,412	8,412	....	.....
Base surface only	18.467	3,537	88,420	32.236	106,472
Bridges	....	.....	.....	....	14,386
Concrete widening	....	.....	.....	0.721	26,872
Concrete only	....	.....	.....	1.077	47,271
Totals	174.090	$1,367,728	*$2,188,484	353,279	†$2,416,954

*4 railroad grade separations included in the above.
†2 railroad grade separations included in the above.

NR secondary projects completed during 1934, the majority of which were started in November and December, 1933, amounted to 191 miles, graded, drained and surfaced at an estimated cost of $1,255,000.

The estimated cost of NR-WR projects completed in 1934 was $824,710, involving grade and drain only, 129 miles; and grade, drain and surfaced, 180 miles. These projects were started late in 1933.

The 1935 construction includes the following:

SUMMARY OF NRH, NRM AND STATE CONSTRUCTION CARRIED OVER INTO 1935

Type	Mileage	Total Cost	Cost of Portion Completed in 1934
Grade and drain	19.098	$ 285,638	$136,255
Grade, drain and base	28.867	350,488	183,876
Grade, drain and concrete	0.929	69,098	6,910
Grade and drain and oil or reconstruction and oil	49.562	683,789	231,662
Grade, drain and rock asphalt	6.252	105,533	63,320
Oiling only	46.125	176,697	100,321
3 bridges	0.549	155,556	18,207
Totals	151.382	$1,826,799	$740,551

Two railroad grade separations included in above.

Landscaping projects $60,000

1935 *NRS Projects Awarded During* 1934 *Carried Over Into* 1935:

49.2 miles grade, drain and surfaced—estimated cost, $352,684, of which approximately $28,693 was earned in 1934.

Balance of 1935 *NRS Program—To Be Awarded and Constructed in* 1935:

34.6 miles to be graded, drained and surfaced at an estimated cost of $360,000. 8.0 miles to be surfaced at an estimated cost of $30,000.

F.E.R.A.—Forty FERA highway projects for which the Highway Department has agreed to share the cost. Starting in 1934, carrying over into 1935. Mileage not available. Estimated cost $508,834, of which the Highway Department has obligated itself to pay an estimated amount of $98,453.

The 1935-36 programs will not start until July 1, 1935, and no programs have been preparing covering work to be done during this period. New Mexico's allotment of the $125,000,000 will probably be slightly less than $2,000,000, which is to be matched with approximately $1,200,000 of State funds, making in all a program of approximately $3,200,000. It is estimated that at least one-half of this will be placed under contract by Jan. 1, 1936.

G. D. Macy, Santa Fe, N. Mex., is State Highway Engineer.

Wyoming

The total expenditure of the State Highway Commission for the biennial period, Oct. 1, 1932 to Sept. 30, 1934 were $10,495,420, divided as follows: Construction, $7,964,420; maintenance, $1,347,518. The construction program involved 383 miles of grading and draining; 342 miles of base course surfacing; and 632 miles of oiling. The program required approximately two million tons of crushed rock material, thirty thousand tons of concrete aggregates, and fifteen million gallons of bituminous oil.

Nevada

The following is a summary of the highway contracts awarded by the state highway department in 1934:

	Miles
Graded	6.00
Graveled oil	639.89
Road mix	482.28
Plant mix asphalt	43.43
Emulsified asphalt	2.11
Asphaltic concrete	11.74
Portland cement concrete	6.92

The tentative construction and maintenance budget for 1935 includes the following:

	Miles	
New construction	137.11	$1,099,000
Reconstruction—Gravel	82.92	520,000
Reconstruction—Oil treated gravel	80.53	573,000
Reconstruction—Plantmix asphaltic surface	27.38	385,000
Reconstruction — Cement or asphalt concrete surface	9.45	342.000
Bituminous treated surface	239.10	601.000
Roadside beautification	44.00	21,000
Footpath construction	2.00	2,000
Construction grade crossing signals	....	3,600
Bridges	....	210,000
Total construction program		$3,756,600
General maintenance		555,467
Specific maintenance		63,033
*Maintenance administration		31,500
Total budget		$4,406,600

*Includes administrative salaries, industrial insurance, office expense, travel expense, auto expense, division offices and headquarters on maintenance.

Colorado

The following annual budget of the State Highway Department was approved Dec. 13 by the governor:

ESTIMATED RECEIPTS

Federal Aid	$2,290,500
Additional revenue or loan (if obtained)	890,500
70 per cent gasoline tax	3,660,000
Bus and private carrier	50,000
Internal improvement	30,000
Miscellaneous receipts	50,000
Total	$6,971,000

ESTIMATED DISBURSEMENTS

Federal Aid Projects (Class A)	$2,800,000
Federal Aid Projects (Class B)	1,781,000
(If additional revenue or loan, as shown above, is obtained.)	
1933 State Funds Appropriation 79-F	40,000
State projects—Oiling	500,000
Maintenance and equipment	1,500,000
Surveys	45,000
Traffic signs and census	55,000
(Includes $14,000 for Economic Survey.)	
Property and equipment	25,000
Compensation insurance	25,000
Administration	200,000
Total	$6,971,000

Chas. D. Vail, Denver, Colo., is State Highway Engineer.

Washington

During the calendar year 1934 there was completed under the direction of the State Highway Department the following:

	Miles
Cement concrete paving	34.9
Asphalt concrete paving	4.6
Grading	41.0
Grading and surfacing	44.1
Surfacing	162.9
Bridges	1.4
Oiling	412.9
Guard rail	10.2
Riprapping	0.3
Landscaping	11.7

Regarding the above item, "Guard Rail—10.162 miles," this covers only straight guard rail jobs. Guard rail is involved in grading, surfacing and paving contracts.

The amount of work under construction and not completed in 1934 is as follows:

	Miles
Pavement	27.6
Grading	30.1
Grading and surfacing	16.1
Surfacing	35.2
Bridges	0.9
Oiling	33.4
Landscaping	8.8

The unexpended portion of obligated funds for the construction work not completed in 1934 amounts to $2,192,780.

Nothing definite can be given at the present time regarding the 1935 construction program. The Depart-

ment will submit to the state Legislature, which convenes next month, a new highway code, and the funds available for construction work depends on what the coming legislature appropriates. Under the present statutes allocating motor vehicle fees and gas tax monies, there would be available only sufficient money to match the Federal Aid allotment to this state, which allotment is approximately $1,900,000.

L. V. Murrow, Olympia, Wash., is State Highway Director.

Oregon

By making use of Oregon's 1934 NRA allotment of some $6,000,000 and with nearly $800,000 state funds, there were constructed the following mileages of highway improvement in 1934:

	Miles
Concrete paving and widening	20
Bituminous macadam wearing surface	130
Oil treatment	72
Crushed rock surfacing	51
Grading and grade widening	72

More than one-half of the 1935 NRA program was placed under contract prior to January first. Less than $150,000 was disbursed for work performed in 1934, however, and no mileage completed for this expenditure.

The following is a summary of the various classes of work included in the 1935 NRA construction program:

	NRH	NRS	NRM	Total
Grading	26.6	40.0	2.0	68.6
Surfacing	29.7	44.2	.5	74.4
Paving	6.1	...	13.3	19.4
Oiling	8.8	11.7	...	20.5
Bituminous macadam	...	7.9	.6	8.5
Bridges (number)	5	7	3	15

The estimated cost of the above program classified as to kinds of work is as follows:

	NRH	NRS	NRM	Total
Grading	$ 966,000	$343,000	$ 97,000	$1,406,000
Surfacing	181,000	189,000	3,000	383,000
Paving	270,000	......	491,000	761,000
Oiling	70,000	100,000	......	170,000
Bituminous macadam	....	41,000	10,000	51,000
Bridges	118,000	158,000	200,000	476,000
Landscaping and R.R. crossing signals	37,000	......	12,000	49,000
Totals	$1,642,000	$831,000	$803,000	$3,296,000

Expenditures during 1934, in connection with this program have amounted to approximately $150,000, leaving about $3,150,000 to be carried over to 1935.

Construction activity on the five PWA Coast Bridge contracts will be at its peak in 1935, with an estimated expenditure of $3,500,000.

It is anticipated that there will be approximately $4,000,000 available for highway construction under the Federal Aid Program during 1935, one-half of which amount will be from state funds and one-half from Federal funds. No allotments of these funds have been made to individual projects.

In summarizing the amounts available under the three programs referred to, it can be reasonably expected that Oregon's expenditure for highway improvement will total not less than $10,000,000 during the year 1935, approximately one-half of which is already under contract.

R. H. Baldock, Salem, Ore., is State Highway Engineer.

California

California's highway construction program is established upon the basis of a biennial budget which is subject to the approval of the state legislature. The biennium covered by the next budget will include the period from July 1, 1935, to June 30, 1937.

At the moment (Dec. 18), this budget is in the preparatory stage prior to its submission to the state legislature, which convenes on Jan. 7, 1935. However, the construction budget as it will be presented to the legislature will amount to approximately $36,000,000 for the two years from July 1, 1935, to June 30, 1935. This figure includes some $27,000,000 in state funds and estimated Federal aid of about $9,000,000 for this two year period.

The total allocation of $36,000,000 includes major construction projects, betterments, minor improvements, Joint Highway District projects, right of way, preliminary and construction engineering.

During the first few months of 1935, many projects, financed from the 1935 Federal grant under the Hayden-Cartwright Act will be placed under way.

Under this section of the Hayden-Cartwright Act, California was apportioned $7,932,206. Of this amount, nineteen projects amounting to well over $2,000,000 have been let to contract or are now (Dec. 18) advertised for bids. It is anticipated that by Jan. 1, 1935, over $3,000,000 in this Federal program will have been advertised. The remainder will be placed under way early in the year, so that there will be no delay in getting the regular biennial program covered by the budget, which is to be submitted to the legislature, under way after legislative approval has been obtained.

As a gauge of California's progress in advancing the state highway construction program, it is noted that since Jan. 1, 1934, major projects amounting to $15,650,000 have been put under way or advertised. These projects included all types of construction and the following summary shows the mileage of various types and the amount expended for each type:

Work Put Under Way Since Jan. 1, 1934

Type	Miles	Amount
Pavement	144.4	$ 7,249,900
Bituminous treated crushed rock surface	92.5	2,044,700
Untreated crushed rock surface	18.5	438,500
Graded roadbed	71.8	1,861,000
Bridges and grade separations (62)	.....	3,221,600
Oil treated shoulders and roadbed	1,699.5	665,800
Miscellaneous work	.....	195,000
Totals	2,026.7	$15,676,500

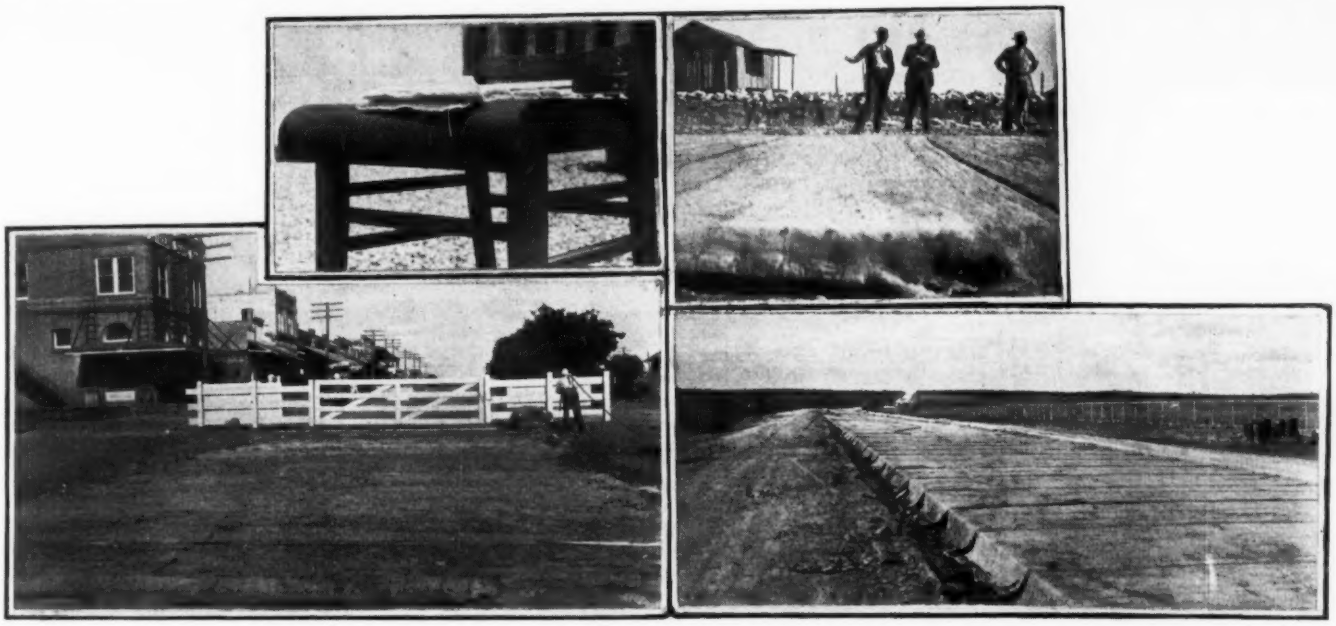
C. H. Purcell, Sacramento, Calif., is State Highway Engineer.

Trucks Paid Special Taxes of $303,000,000 Last Year

In 1933 this country's motor trucks paid $303,467,260 in special truck taxes, exclusive of personal property taxes, property taxes, and income taxes. This amounts to $94.50 per truck. Of this total by far the largest amount was in the form of state gasoline taxes, which amounted to $143,200,000.

The special truck taxes may be itemized as follows:

State gasoline taxes	$143,200,000
State registration fees	70,298,260
Federal excise taxes	61,936,000
Municipal license fees and gas taxes	17,500,000
Driver and trailer licenses	10,533,000
TOTAL SPECIAL TAXES (not including property or income taxes)	$303,467,260



Upper Left—Cross Section of Cotton Mat Used in Texas for Curing Concrete Pavement—Showing 12-oz. per Sq. Yd. of Cotton Center Filler Between Two Covers of 6.3-oz. per Sq. Yd. Cotton Cloth.
Lower Left—Curing Concrete Pavement with 24-oz. Weight per Sq. Yd. Cotton Mats. Kept Dripping Wet for 72 Hours and Removed on Texas Highway No. 3 in Gonzales Co. SP-982-C. *Laid During Hot, Dry Summer,* 1934. *Upper Right—Curing Concrete Pavement with 24-oz. Weight per Sq. Yd. Cotton Mats. Kept Dripping Wet for 72 Hours and Removed. On Texas State Highway No. 2 in Bell Co., U. S. Public Works NRH No.* 4. *Laid During Winter and Spring,* 1934. *Lower Right—Curing Concrete Pavement with 24-oz. Weight per Sq. Yd. Cotton Mats. Kept Dripping Wet for 72 Hours and Removed. Texas State Highway No. 2 in Bexar Co.* SP-1071-A. *Laid During Hot, Dry Summer,* 1934.

USE OF COTTON MATS FOR CURING CONCRETE

By STANLEY ANDREWS

A SERIES of tests in the use of cotton mats for curing concrete was conducted last year by the Soils and Research Division of the State Highway Department of Texas under the direction of Henry C. Porter.

According to the tests each mat can be utilized at least 50 times and some were used as many as 72 times. Under the use of the cotton mats they are simply spread over the concrete and kept dripping wet for 72 hours.

The Texas Specifications.—The specifications set out for the mats and the methods to be followed are set out in the following special provision published by the Texas Highway Department.

All concrete pavement shall be cured with saturated cotton mats as outlined below.

"As soon as the concrete pavement has been finished as prescribed, and as soon as, in the judgment of the engineer, the concrete has set sufficiently that the surface will not be marred, the surface of the pavement shall be completely covered with thoroughly saturated cotton mats, in such a manner that the cotton mats will contact the surface of the pavement equally at all points.

"The cotton mats shall be kept dripping wet and shall remain on the pavement for a period of at least 72 hours. The cotton mats when placed on the pavement, or raised at any time during the curing period, shall drip water.

"The cotton mats shall meet the following requirements:

"Each mat shall have a finished width of approximately five feet six inches (5ft. 6 in.) and a length two feet greater than the width of the pavement to be cured—after the mat has thoroughly shrunk. (The mats shall be made sufficiently oversize in both length and width to allow for shrinkage in use.)

"The mats shall be composed of a single layer of cotton filler completely enclosed in a cover of cotton cloth.

"The cotton filler shall be of low grade cotton, cotton linters, or such cotton waste as comber noils or card flat strips.

"The mats shall contain not less than three-fourths (¾) of a pound of cotton filler per square yard of mat, uniformly distributed.

"The cotton cloth used for covering material shall be osnaburg weighing not less than six and three-tenths ounces (6 3/10) per square yard.

"The cover for each side of the mat shall be of two (2) widths of cloth joined by a strongly stitched lapped seam. The sides of the cover shall be fastened together along both edges and the ends by means of strongly stitched seams.

"All mats shall be stitched longitudinally with continuous parallel rows of stitching at intervals of not more than four inches (4 in.), or shall be tufted both transversely and longitudinally at intervals of not more than three inches (3 in.). The sewing or tufting shall not be done so tightly that the mat will not contact the

surface of the pavement at all points when saturated with water.

"To insure the complete covering of the pavement where the mats fit together, there shall be a flap extending all along one side of each mat. This flap shall be composed of two thicknesses of the cover material and shall be approximately six inches (6 in.) wide. The flap shall be strongly stitched along the edge so that it will lie flat on the pavement."

The Tests.—Seven mats of slightly different design and weights were furnished by the Crawford Austin Mfg. Co., of Waco, Tex., the Itasca Cotton Mills of Itasca, Tex., and the New Haven Quilt and Pad Co. of New Haven, Conn. They were placed on pavement for the first time on Dec. 21, 1933, used continuously until May 8, 1934—remaining at a placement and kept dripping wet with water for a minimum period of 72 hours—being used 21 times when the 12-mile project was completed.

On June 25 they were placed on another project and kept dripping wet a minimum of 72 hours at a placement until that 16-mile project was completed on Oct. 3, 1934—used on 19 placements.

Between the dates of Oct. 10th and Nov. 24th they were used 7 times on another project, making a total of 47. They still have more service in them and it is conservative to say they will stand 50 placements.

Other methods of curing were employed along with that of the cotton mats on the first two above named projects. Test cores cut from the pavement showed that cured with the mats for 72 hours was as strong as any of the other on the first project and the average for that of the mats was the highest on the second project.

The cost of the 72-hour cotton mat methed was about the same, or a little less than the 10-day wet-burlap-wet-earth method which has been the most general method used in Texas.

Conclusion of Texas State Highway Department.—In a final report on extensive tests with cotton mats for curing concrete the highway department offers the following conclusions:

The experiments performed to date with the cotton mats have proved very efficient in comparison with the old method of covering with wet burlap for 24 hours and then with wet earth for 10 days as follows:

1. The cotton mats kept dripping wet for 72 hours and then removed have made as high or higher compressive strength concrete.
2. The cotton mat method has cost no more per square yard of pavement cured, figuring the mats stand 50 placements, which they have done.
3. The curing is more uniform, as a film of water is held over the entire length and width of the pavement, which can be easily inspected. (It is difficult if not impractical to determine whether or not the earth covering is uniformly wet next to the concrete.)
4. Where wet burlap is replaced by a covering of earth there is a period between the times the burlap is removed and the earth is applied, at the time the pavement needs protecting the most. Also the earth is often more or less dry when it is placed on the pavement and probably robs the concrete of moisture where it is not wetted at the instant it is placed.
5. Where the subgrade and shoulders of the roadway are constructed of selected soils, it is not disturbed or contaminated during pavement construction when cotton mats are used.
6. Where the concrete is a base for covering with bituminous topping, the sacrificed surface of the base is perfectly clean when the topping or wearing surface is applied to it and a better bond is obtained between the two.
7. Where pavement is laid on city streets where dirt for covering material is not available and must be hauled from outside the city and hauled out again the mats are much more economical.

▼

Highway Contractors Want Code of Their Own

The following action was taken by the Highway Contractors' Division at their meeting in Washington during the 32nd Annual Convention of the A. R. B. A., and was submitted by letter ballot to the Board of Directors of the Association, and passed:

> Moved and Carried that this meeting (highway contractors) go on record as favoring a Highway Contractors' Code, and that the presiding officer appoint a committee of five to immediately consider and formulate plans for the adoption of a Highway Contractors' Code, for presentation after the appropriation bill by Congress has been passed.

▼

Progress on Public Works Highways

Progress made on emergency construction of public works highways to Jan. 26 under the supervision of the U. S. Bureau of Public Roads shows a total of 566 projects, estimated to cost $25,451,000, approved but contracts not yet awarded; 855 projects, estimated to cost $35,378,000, awarded but not yet under construction; 2,411 projects, estimated to cost $145,879,000, under construction; and 7,625 projects completed at a cost of approximately $337,555,000. The 2,411 projects under construction involve 6,890 miles of road and are giving regular direct employment to 87,521 men. The above figures include projects involving funds provided by the Acts of June 16, 1933, and June 18, 1934.

▼

Simplified Practice Recommendation for Steel Reinforcing Bars, Reaffirmed—Simplified Practice Recommendation R-26-30, Steel Reinforcing Bars, has been reaffirmed, without change, by the standing committee of the industry. This simplification program reduced the number of cross-sectional areas of reinforcing bars from 32 to 11, and limits the equivalent cross-sectional areas of the bars to 2 decimal places. The recommendation was first promulgated in 1925, and was reaffirmed, without change, in 1926, 1927, and 1928. The original program was modified in 1930. Copies of the recommendation may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cts. each.

▼

France to Spend $650,000,000 for Public Works—According to Lestrade Brown, U. S. Assistant Trade Commissioner, Paris, the final building program approved by the French Ministry of Labor in order to alleviate unemployment in France includes the following to be executed by collective bodies: Work on departmental roads, 200,000,000 francs, and public works (roads, maritime ports and interior navigation), 1,315,-000,000 francs. All construction and work projects are estimated to cost 10,000,000,000 francs for unemployment relief. A special commission is to be created in Paris for the purpose of insuring that the work shall be reserved for French workmen now unemployed, and that they shall be given priority. The materials are to be obtained in France and the colonies as far as possible. Equipment must be French or shall have paid custom duties prior to Jan. 1, 1934.

MULCH TOP CONSTRUCTION

On Old Gravel Road in Indiana

Photographs from A. O. Hastings
Field Engineer of Construction
Indiana State Highway Commission

An Old Gravel Road Before Mulch Top Is Constructed on Same

Same Old Gravel Road After It Has Been Primed with Bituminous Material Mixed in Place Mulch.

Mix Operation with Power Grader

Mixing and Spreading Mixed in Place Mulch with a Multiple Blade Machine

Finished Surface After the Mulch Course Is Laid. Ready to Open to Traffic

Texture of the Finished Wearing Surface on the Mulch Road

EDITORIALS

Shall Highway Planning Be on a Scientific or Political Basis?

HIGHWAY planning by legislative enactment has resulted in the construction of some roads not justified from the standpoint of cost or usefulness even by increased traffic. Not only are the errors of legislative planning, based in many cases on the pleas of delegations actuated by self-interest, evident in the widening and even abandonment for better locations of comparatively new roads but, more alarming, there are many miles of high type roads that accommodate so little traffic that they appear to be monuments to poor planning.

Errors made in past democratic but unscientific planning by popular clamor have been covered up or neutralized by the remarkable increase in motor vehicle traffic during the past decade. But now the traffic is not increasing nor will the past rapid rate of increase be repeated in the future. We have reached the point where future road improvement must be judged by more rigid rules. The liability to expensive error has been increased by the fact that the main roads, rather easy to select as to traffic importance, have nearly all received some degree of improvement. We now have before us the problem of improving the secondary roads. These secondary roads comprise the great body of the 3,000,000 miles of rural roads in the United States. Let it be remembered that the State and Federal-aid systems of highways include less than 360,000 miles, about one-eighth of the total highway mileage of the country.

In the past it has been the policy to build the main roads first. This has been a just and a democratic policy because in this way the greatest number of people were benefited at the least cost per person. The main road work of the past has been well done but the problem of providing a continuous good road from farm to market yet has to be solved.

It is evident that the greater the number of people served the greater will be the benefit to the community or State and the larger will be the return to the State in gasoline taxes. What roads will serve the most people, not only the traffic on the road but the people served by motor traffic?

It is also evident that once the main roads have been improved under the protection of the wise State system priority of past years, there is the problem of selecting from the 2,640,000 miles of road not in the State highway systems what roads shall be improved first and what degree of improvement is justified. Under the system of selection by handclapping or public applause the door is left wide open to political log rolling on a scale not yet dreamed of.

Attention was called to the importance of proper advance planning of highways in the address of Thos. H. MacDonald, chief of the U. S. Bureau of Public Roads, before the American Association of State Highway Officials in Santa Fe, N. Mex. Mr. MacDonald said in part:

"The course we have been following has been fairly clear. The choice of the most important roads has been rather obvious. What we have been doing is what the President calls "doing first things first." That we have done it rather well the generally appreciated usefulness of the Federal aid and State highway systems testifies without the factual aid of the many traffic surveys.

"We now approach more difficult decisions. As each additional mile of highway is improved, the choice of succeeding mileage for improvement becomes progressively a matter of narrower and narrower margins. And the future extensions of improvement will be in a class of roads on which there can be expected no such growth of traffic following the improvement as we have experienced on the roads with which we have hitherto been dealing. All the facts at our disposal indicate that the further extensions of improvement must enter the class of land-service roads, as distinguished from the general-use highways with which, as State and Federal officials, we have been primarily concerned in the past. And, since no amount of improvement will convert a typical land-service road into a road of general use, the only traffic increase to be expected is that which may result from the development of a denser population or more active industry on the land immediately served. No great waves of new traffic will come flooding to these roads, such as we have in the past experienced on the main roads. So there will generally be no counting upon future traffic growth to justify any serious mistakes of over-development that may now be made. . . .

"The task involved is one for which there are no agencies, other than those represented in this Association, that are fitted. It is one that should be accepted with the determination to carry it through from the beginning in strict accordance with economic and social principles.

"As a first step it seems to me there is need in every State of a traffic survey directed to the discovery of the roads additional to those already constructed, improvement of which may be justified on reasonable grounds of economy or social usefulness. If authority to undertake such studies does not at present reside in any of the State highway departments, such authority should be sought at the coming legislative sessions.

"For such planning purposes, as you know, the last Federal Act makes available up to 1½ per cent of the funds apportioned to the States; and there is no better use to which such sums can be put in the present stage of highway development."

The highway planning problem is upon us. It will be solved by the highway departments, or it will be solved by State legislative commissions, such as have been constituted in New York, Virginia and Washington, to survey, study and evaluate the highway situation and to draft an economical policy and program based on present and future traffic needs.

The chief question is, Shall the work be done with scientific or political emphasis? In the interest of economy and to protect the public it is clear that unbiased planning free from handclapping methods is much to be preferred.

NEW EQUIPMENT AND MATERIALS

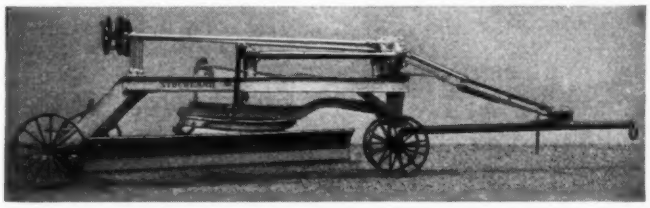
New Grader

Foote Bros. Gear and Machine Co., Road Machinery Division, Joliet, Ill., announces their new Model "40" Stockland grader for operation with small tractors of 10 to 20 H.P. on maintenance and side road reshaping work. This grader ordinarily has a 7- or 8-ft. moldboard and weighs approximately 3,200 lb.

The straight line Stockland construction has been maintained throughout the design, allowing low overhead to escape overhanging trees.

The practical feature for townships and small municipalities rests in the new type of grader controls. The construction is such that the grader may be used for reshaping shoulders, clearing out ditches, etc., at which time it is operated with rear-end controls as in the ordinary grader. The controls consist of hand wheels located in a convenient position in front of the operator's platform. Then when grader may be needed for road maintaining purposes, in less than 15 minutes the controls may be reversed to the front of the grader and thereby arranged so one man—the tractor driver—can operate both grader and tractor.

The grader is of heavy construction design throughout, the



New Model "40" Stockland Grader

frame being of 6-in. channel and the drawbar of 3½-in. tee section. When used for continuous maintenance work, 10 or 12-ft. length of moldboards can easily be used.

▼

New Fuel Oil Burning Engines

Continental Motors Corporation, Detroit, Mich., has announced recently a line of overhead valve feed oil burning carbureted spark ignition tractor and stationary engines.

Ordinary furnace oil (No. 1) is used in these engines with the same efficiency, it is stated, as obtained from good commercial grades of gasoline. When operating on No. 1 fuel oil, no difference can be discerned, it is claimed, as far as acceleration, power and smoothness of operation are concerned. There is a total absence of smoke at varying loads, only slightly visible puffs of white vapor at moments of deceleration.

The entire development has been thoroughly engineered and tested in actual field operation, using conventional carbureted spark ignited engines with Continental features. Accurate crankcase dilution checks are stated to run from 3 to 5 per cent dilution, depending on the application. These dilution tests have been made by a distillation process; samples of oil were taken from engines operating in atmospheric temperatures of from 8 to 70 degrees above zero, under all climatic conditions.

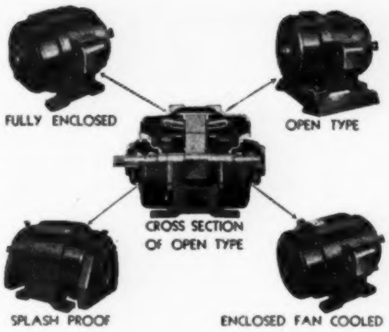
Power units, both open and closed models, and industrial engines are now available in six cylinder heavy duty type of 381, 428 and 501-cu. in. displacement.

▼

New Line of Convertible Motors

An entirely new line of convertible squirrel cage and slip ring induction motors, offering all standard frequencies for service ranging from 110 to 220 volts, has just been announced by the Harnischfeger Corporation, West National Ave., Milwaukee, Wis.

Built in accordance with the standards adopted by the National Electrical Manufacturers Association, the outstanding feature of these new P&H motors is their ready convertibility from



Types of New Line of Convertible Motors

open type to fan cooled, splash proof or totally enclosed construction. This is accomplished through the design of the frame, end heads and bearings to permit interchangeability in the four above mentioned types of single or multi-speed squirrel cage and slip ring motors.

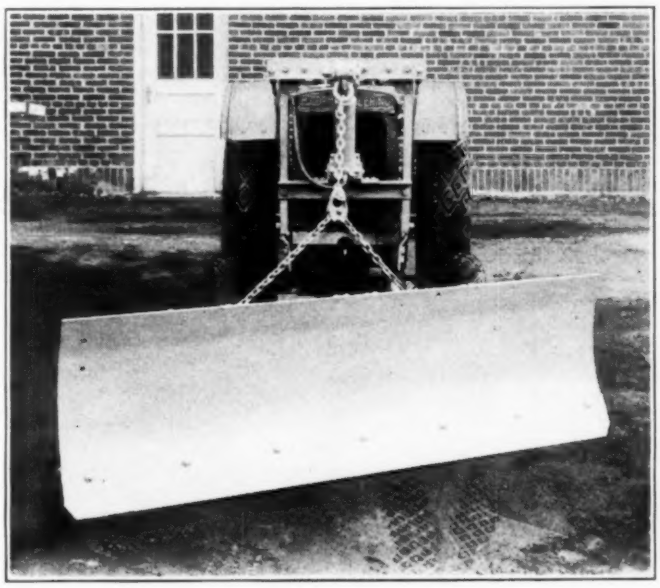
Among the other interesting features is the unique mounting of the stator laminations which are stacked between heavy steel end rings and the entire assembly then welded to the frame. This construction provides absolute rigidity and makes it impossible for the stator core to shake loose.

The rotor windings are assembled from round or rectangular hard drawn copper bars which are placed in the rotor slots without insulation or slot wedges. The ends of the bars are brazed to the end rings by an electric arc torch.

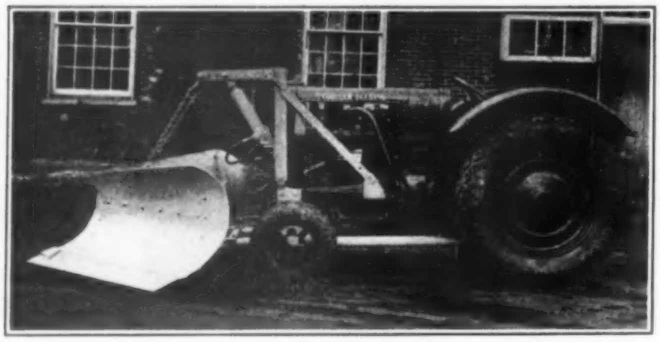
▼

Small Reversible Blade Plow for Tractor

A snow plow built for use with four-wheel tractors and claimed to be particularly efficient for snow removal in limited areas, where, owing to restricted space or the presence of fixed obstructions, standard truck plows cannot operate, has been brought out by the Good Roads Machinery Corporation, Kennett Square, Pa. This "Good Roads" Model 16-D has a 6 ft. 6 in. blade, is fully reversible, and light and compact. It embodies all the outstanding features characteristic of all "Good Roads" blade type plows, including the automatic safety blade trip, hand hydraulic lift, roller-bearing, full swivelling, spring mounted castor wheels supporting the plow and reducing the frictional load on the tractor, thus conserving the maximum motive power for snow removal. A unique self-locking screw adjustment in castor housings permits vertical adjustment of the blade to compensate for natural wear on renewable cutting edge. Variable plowing and tilting adjustments of the blade are provided for most efficiently, meeting different snow conditions. The plow oscillates freely to conform to surface contour. The under-frame attachment is



Blade Plow Model 16-D



Model 18-CV V-Plow

connected at rear of tractor in such manner that the thrust load is properly distributed to the tractor framework. There is no push connection to front axle or to any part of the front end of the tractor. Once the push frame and lifting device are in place the plow may be attached in a very few minutes and as neither attachment interferes with the operation of the tractor in general use. The plow when not required is kept at a convenient point for quick attachment when needed.

Where, through conditions or preference, a small "V" type plow is required, "Good Roads" Model 18-CV can be had, as it is fully interchangeable with Model 16-D reversible blade type illustrated, using the same under frame and lifting device. Both Models 16-D and 18-C are furnished, with longer blades and greater width of "V," for use with 1½ ton capacity trucks.

▼

Nitramon: A New Blasting Material

A revolutionary new blasting material for use in quarries and in other blasting operations such as stripping, was announced at the Eighteenth Annual Technical Section Convention of the Explosives Department of the du Pont Company, which opened Jan. 22, at Wilmington, Del. This new product, it was stated, cannot be detonated by the strongest commercial blasting cap, by impact, by flame, nor by shooting a rifle bullet into it. In actual use it is exploded by means of a large diameter cartridge of dynamite. It is non-headache producing and is rendered absolutely water resistant by being sealed up tightly in a tin can. It is stated to represent the ultimate in safety insofar as a blasting agent is concerned. It represents a very radical departure in the explosives field. This new development has been covered by two patents, one for the product itself and the other covering its method of use. It is non-freezing. It was announced yesterday that it will be known as "Nitramon."

The new product will be marketed only in large diameters, for example, 4-in., 4½-in., 5-in. and 7-in. It is adapted solely for use in large diameters and has been designed specifically to fulfill as nearly as possible the ideal qualifications for use in quarries and in coal stripping operations.

The fact that it cannot be detonated by any of the ordinary means used to detonate explosives makes it safe for transportation in a degree hitherto unknown for any blasting agent.

Work on this new explosive has been going on for months. It has been tested both in the laboratory and in the field and by agencies outside the company.

▼

A New Giant Stripper

A new stripping shovel, with dippers up to 22 cu. yd. and a working weight of 2,400,000 lb., was recently announced by Bucyrus-Erie Company, Milwaukee, Wis. Unusual in output capacity and working ranges, the 950-B is readily convertible to shovel or dragline operation. It is available with booms up to 110 ft. in length, with dipper handles up to 70 ft. long, and with dippers of 14 to 22 cu. yd. capacities—as may be required to suit pit conditions.

Many features combine to give this big stripper ability to move overburden rapidly, continuously and economically. Individual motors on each of the four crawler units give variable speeds for turning, which is still further simplified by hydraulic steering, minimizing slewing of units and skidding of belts. Savings in output time result from hydraulic leveling—while the machine is digging. The front end of the shovel is immensely strong, yet unhampered by cumbersome unnecessary weight. Added steadiness is given the dipper by twin, single-part hoists. Power peaks are reduced by Bucyrus-Erie counterbalanced hoist.

These and many other unusual, practical features make the new 950-B as sound in detail as it is impressive in the whole.

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WITH THE MANUFACTURERS

Men of Prominence in Industrial Ad Clubs

Quite a number of advertising managers of manufacturers selling equipment in the highway field are holding responsible positions in industrial advertising associations in the Ohio-Pennsylvania sector.

D. Clinton Grove

A. E. Hohman

Mr. D. Clinton Grove and Mr. A. E. Hohman, Advertising Manager and Assistant Advertising Manager, respectively, of Blaw-Knox Company were recently elected President and Secretary-Treasurer, respectively, of the Industrial Advertising Council of Pittsburgh.

J. L. Beltz

Mr. J. L. Beltz, Advertising Manager of Thew Shovel Co. and Universal Crane Company of Loraine, is Vice-President of the Industrial Marketers of Cleveland, and has long been an active member of that association.

Mr. Louis R. Beck, Advertising Manager of Cleveland Tractor Company, is a member of the Board of Governors of that same organization.

Mr. Allan E. Beach, Advertising Manager of Littleford Bros., was recently re-elected Secretary-Treasurer of the National Industrial Advertisers' Association.

▼

New Loadmaster Distributors

Bucyrus-Erie Co., South Milwaukee, Wis., announce the appointment of C. G. Landes, 62 South High St., Columbus, O., as loadmaster distributor for the central portion of the State of Ohio. Collier Tractor and Equipment Co. have also been appointed loadmaster distributor for the Northern and Western sections of the State of Nevada as well as the Northeastern portion of the State of California. Their offices are located at 502 East 4th St., Reno, Nev.

▼

Rutan District Sales Manager for Penn.-Dixie

The Pennsylvania-Dixie Cement Corporation has announced the appointment of Paul J. Rutan to the position of District Sales Manager of the Rochester, N. Y., office succeeding H. C. Carpenter who has been transferred to General Sales in New York.

ROADS AND STREETS

with which is merged Good Roads and Engineering and Contracting.
Covering design, construction, maintenance and traffic control

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